The German Giants

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"However, if I had waited long enough I probably never would have written anything at all since there is a tendency when you really begin to learn something about a thing not to want to write about it, but rather to keep on learning about it always, and at no time unless you are very egotistical which of course accounts for many books will you be able to say now I know all about this and will write about it."

Ernest Hemingway *Death in the Afternoon*

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Staaken test pilots commemorating the completion of the 25th Staaken R-plane, an R.XIVa. Third from the right is Willy Mann who flew the first R-plane built by VGO.

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The authors owe a great debt of gratitude to the many individuals and organizations who so freely and graciously contributed to the compilation of this book. Particular mention is due to those veterans (now alas, very few) who actually participated in the development and operation of the R-planes; they extended to us their records and recollections of those early days and generously allowed us to use photographs from their albums. Our sincere thanks go to: Oblt. a. D. Max Borchers, one of the first members of Rfa 501 and last commander of Rfa 500; Paul Büttner, a ground crew member in charge of gyro-compass installation and servicing, whose excellent descriptions provided much background material on the activities of Rfa 501; Oberstabsingenieur a. D. Hans Heitmann, a foreman at SSW, for his fact-filled and often amusing anecdotes of flights at Döberitz and at the Front; Dipl.-Ing. Wilhelm Hillmann, active as a designer in the early aircraft activities of Schütte-Lanz; Hptm. a. D. George Krupp, who first organized and commanded Rfa 501 and later in the war was active in the testing and development of new R-planes for Idflieg; Carl Kuring, second pilot and only survivor of the ill-fated RML.1 (VGO.I) and later test pilot of the Staaken E.4/20; Dipl.-Ing. Richard Lühr, technical officer of Rfa 500 during the early days on the Eastern Front; Wilhelm Pfaff, who served in Rfa 500 during the last months of the war and, as an engine mechanic on the R.45, participated in several bombing raids; Bruno Steffen, designer and test pilot, who provided much interesting material regarding the Siemens-Schuckert R-planes; Dipl.-Ing. Harald Wolff, chief of the SSW aircraft design bureau during the war, and to Frau E. von Bentivegni for details concerning the life of her husband, the long-term commander of Rfa 501. Working with the above has been a rewarding pleasure, and we hope they have enjoyed reminiscing about the past as much as we have enjoyed hearing and reading their stories.

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The authors also wish to express their thanks to Mrs. Peter Grosz for valuable assistance in preparing the manuscript.

ACKNOWLEDGEMENTS TO THE 2ND EDITION

New contacts with surviving R-plane personnel, brought about by publication of *The German Giants* six years ago, has added many details to the story of these fascinating machines, and made possible this revised second edition.

We would like to extend our appreciation and thanks to all the following who were involved in the development of R-planes. Phillip Simon, the man responsible for quality control and stressing at VGO-Staaken, for his first-hand account of activities at Gotha and Staaken. Max Schaefer, one of the original employees of VGO, for his recollections and for allowing us to delve into his superb photo album. Erich Bruno Schröter, Dornier test-pilot, who shared his early memories with us. To Direktor Jäger, who began a life association with Dornier as a test pilot in the

First World War, who made available to us portions of the Dornier archives. Also to Werner Zorn, who as a young man worked in the AEG design office, for new material concerning the AEG R.I. Also to Mr. Fiedler, who witnessed the break-up of the AEG R.I from an accompanying aircraft.

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ACKNOWLEDGEMENTS TO THE 3RD EDITION

Almost twenty-five years have passed since *The German Giants* was first published. We never dreamed that there would be a second indeed even a third edition of this work. During the intervening years, our interest in German R-planes has remained active with the result that new documentation and photographs have been gathered, but we were pleased to note that in preparing this amended third edition, the text as originally published required only minor additions and corrections. Some of the photographs have been replaced by superior ones that we feel are more descriptive of the subject matter. We have dropped the individual photo credits since the originals of most photographs are in the authors' possession or have been supplied by several sources. All photograph contributors are given credit in the acknowledgements.

In addition to the persons mentioned in the previous acknowledgements, we should like to express our thanks to Dr. Holger Steinle of the Museum für Verkehr und Technik in Berlin and Dr. Siegfried von Weiher of the Werner von Siemens Institut in Munich who have been most supportive of our efforts with documentation and photographs and finally to Dr. Volker Koos of Rostock for his photographic contributions.

Only a few of the R-plane pioneers who appear in the text are still with us. Our deep respect for these stalwart pioneers—engineers and aircrews alike—remains undiminished. To them and all those who helped and supported our endeavours through the years, our deep and grateful thanks.

INTRODUCTION

The great technological progress made during World War II was the natural product of a time when the expenditure of vast sums of money and material was secondary to the achievement of victory. The enormous scientific endeavour, in which all nations shared, has provided the key to the harnessing of atomic energy and has placed mankind on the threshold of interplanetary flight. In World War I, technology played a similarly dramatic role in advancing the science of aeronautical engineering. Aeroplanes grew from simple wood-and-wire flying machines to the sophisticated all-metal aircraft which were being built on a production-line basis at the close of the war.

No small part of this progress belonged in the field of giant aircraft development, particularly in Germany. German engineers in a few short years had spanned the gulf between crude wooden biplanes and all-metal, multi-engined, monoplane giant bombers.

Much of the story of the German giant bomber has been forgotten or not received its share of emphasis in the annals of aviation history. The purpose of this book, then, is to trace the evolution of the R-plane from its inception, through the war and into the immediate post-war period. The first section of the book describes the R-plane and its operational history. The second section traces the technical evolution of each R-plane type, including as much historical material as has been possible to gather. It is acknowledged that the story is not and perhaps never will be complete, but it is hoped that this work will provide a source of reference and a starting-point for future researches in a fascinating field.

Because the various R-plane types are described alphabetically by company, the following brief history will assist the reader in placing major events and company activities in the proper chronological sequence.

The story of all large multi-engined aircraft began with Igor Sikorsky's "Le Grand", the world's first four-engined aircraft. This signal achievement stimulated the imagination of engineers, flyers and financiers throughout the world, for here was the true promise of flight; a vehicle to conquer long distances at high speeds in relative safety.

In 1913 the *Daily Mail* established a £10,000 prize to be awarded to the first pilot to cross the Atlantic in an aeroplane. Among the many competitors were Glenn Curtiss, with his flying-boat "America" and Handley-Page with their HP L/200. Another aspirant was Hellmuth Hirth, one of Germany's most skilful famous pilots. Hirth proposed a six-engined seaplane to Gustav Klein, the director of the Bosch Works, in the summer

of 1913. With the financial backing of Robert Bosch, Hirth and Klein planned to have the seaplane ready for the transatlantic attempt in the late summer of 1915 and then to place the aircraft in the San Francisco Exhibition of 1916.

The outbreak of World War I forced all plans and aspirations to be shelved. However, Graf Zeppelin, Germany's "father of the airship", saw in the Hirth–Klein project the potential vehicle for carrying large bomb loads over long distances. To this end a corporation was formed and backed jointly by Bosch and Zeppelin, and in September 1914 the construction of the first of a long line of Staaken R-plane bombers started.

One month later, in October 1914, Siemens-Schuckert began to construct an R-plane based on the "Le Grand" formula. This aircraft was not a success despite numerous modifications, and further development of this configuration was stopped. In December 1914 Bruno and Franz Steffen joined with Siemens-Schuckert to build an R-plane based on designs which the Steffen brothers had evolved before the war. A follow-up contract for six additional machines was awarded in June 1915.

The third company to undertake construction of an R-plane prior to 1916 was the Deutsche Flugzeugwerke, but technical difficulties prevented their bomber from reaching operational service until 1917.

During 1915 and early 1916 the few Staaken and Siemens-Schuckert R-planes flying at home and at the front were beginning to show relatively promising results, contrary to the expectations of the majority of the military leaders. The maturing of the R-plane's war potential came at a time when mounting airship losses made the future of the airship as a weapon seem dim indeed. The R-plane, superior in almost every respect, was the natural replacement for the airship as a long-range bombing and reconnaissance weapon. Therefore, the German Army High Command set in motion a large R-plane production programme in mid-1916 which eventually embraced many companies throughout Germany.

By early 1916 two Army R-plane squadrons had been formed to evaluate the fledgling giant bombers, to gather experience under front-line conditions and to prepare for the more powerful R-planes to follow. Known as Riesenflugzeugabteilung 500 and 501 (Rfa—R-plane Squadron), these two squadrons were initially stationed on the relatively quiet Eastern Front. After the collapse of the Russian Army Rfa 500 and 501, equipped with new aircraft, were transferred to the Western Front, where they saw action over England and France until the war's end.

The German Navy did not neglect to investigate the possibilities of the R-plane for naval warfare. Indeed, the Navy supported the Staaken venture from the beginning, and actually placed an order for the first two R-planes built by Staaken. In 1916 a Navy R-plane squadron flew alongside Rfa 500 for a short period of time. Land-based R-planes, however, were abandoned by the Navy in favour of R-seaplanes, the development of which was actively fostered.

Concurrent with the beginning of the Staaken venture in late 1914, Graf Zeppelin, with brilliant foresight, commissioned Claudius Dornier to design and construct all-metal R-seaplanes. At the end of the war both Dornier and Staaken R-seaplanes were under test at Navy experimental stations.

By 1918 R-plane engineering had reached a high level of development, which made the construction of all-metal monoplane bombers feasible. These were to be high-performance and heavily armed aircraft capable of executing unescorted daylight bombing missions. None of these R-planes, destined for Army squadrons, was completed, but their design philosophy was mirrored in the four-engined Staaken E.4/20, the first truly modern transport aircraft. This revolutionary all-metal monoplane was completed in 1920 at a time when the tide of German aviation was at its ebb. One look back at the early Staaken and Siemens-Schuckert giants is visible proof of the swift progress which the German R-plane industry had made in the war years.

PART I

What is an R-Plane?

All aeroplanes used by the German Army in World War I were classified according to their function by one or more letter subscripts. For example, aircraft classified by a "C" were observation aircraft, "D" stood for fighters, "G" for bombers and so forth. The letter "R", the functional classification given to large bombing machines, was an abbreviation of "Riesenflugzeug" (giant aircraft). Although an R-plane's function, like the G-types, was bombing, the R-plane differed not only in size but in more significant aspects, which are discussed later in this chapter. Actually the earliest R-planes were, for a time, classified as G-type bombers, and the "R" classification was not authorized until late 1915.[1]

The functional letter classification was preceded by the manufacturer's name and followed by a Roman numeral to indicate the model (or design) number of the aircraft, i.e., Staaken R.IV. In addition, all Army aircraft were assigned a military serial number followed by two digits representing the year in which the aircraft was ordered, for example: AEG R.I 21/16. In the case of licence-built aircraft the manufacturing firm was represented by an abbreviation of its name as follows: Staaken R.VI (Schül) 27/16. Because relatively few R-planes were built during the war, it was customary to refer to individual machines by their functional letter and serial number in official documents, a practice which is retained in this book, i.e., R.21, R.55, R.75, etc.

The allocation of the military serial numbers for R-planes differed from the conventional system in which the serial numbers were renewed each year. It was possible, for instance, that two different fighter aircraft could have the same serial number, differing only in the year the aircraft were ordered. i.e. D.1220/17 and D.1220/18. On the other hand, R-plane serial numbers were not re-issued yearly, but ran consecutively from R.1/15 to R.86/18. Another exception to the rule was made in 1916, when a block of serial numbers in the R.200 range was set aside for advanced R-plane projects which were still in the design stage or under construction at the close of the war.

What were the criteria by which an aircraft was given the "Riesenflugzeug" classification? If sheer size, weight or horse-power were the hallmarks of an R-plane, then one would expect to find some yardstick by which to measure them. But such was not the case, and the best way to answer the question is to study excerpts from the *Bau und Liefervorschriften für Heeresflugzeuge* (BLV—Construction and Delivery Specifications for Army Aircraft), which regulated the construction of all German Army aircraft. A similar set of specifications which applied to the construction and delivery of all naval aircraft, R-seaplanes included, was known as the *Allgemeine Baubestimmungen für Marineflugzeuge* (ABB—General Construction Specifications for Naval Aircraft).

Initially R-planes were built within the framework of the existing BLV specifications, and by 1916 the BLV already included a handful of special regulations for R-planes. However, these were not nearly comprehensive enough considering the breadth and unique requirements of an R-plane. As a result, by the end of 1916 a BLV intended solely for R-planes was drafted by the Inspektion der Fliegertruppen (Idflieg—Inspectorate of Aviation Troops) and distributed to the various R-plane manufacturers for approval. Known as the BLVR, this document went into effect on 22 January 1917. Although it drew heavily from the existing BLV, it did contain several specifications which set the R-plane apart from all other German aircraft. The BLVR consisted of many pages of detailed technical and engineering regulations; consequently only the most pertinent and illustrative paragraphs are quoted.

Excerpts from the "Construction and Delivery Specifications for R-Planes—1917" (BLVR)

[1] The "R" classification was authorized sometime after 8 August 1915 for on that date an Idflieg document still refers to the VGO.I as the Zeppelin G.I and the SSW R.I and R.II as G.I and G.II respectively.

I. *Arrangement of the Fuselage*

A. *General*—The R-plane is distinguished from G-type and smaller aircraft by its ability to fly for several hours with very large loads. Correspondingly, it is equipped with powerful engines, means for self-defence, navigation instruments and communication devices. The R-plane must be capable of performing short flights with a great load of bombs or very long-range flights without bombs, in which case it should utilize its total lifting capacity to carry extra fuel. Provisions must be made to replace the bombs with fuel tanks on such occasions.

From a military standpoint the ability of the crew to change places quickly is of great value. The fuselage must protect the crew against wind and weather without obstructing the pilots' visibility ahead and to the sides and, above all, the horizon must be visible at all times.

B. *Commander's Position*—The aircraft commander must have a position from which he can easily communicate with the pilots and other crew members. In particular, there must be means for rapid transmittal of messages to and from the wireless operator. If the flight mechanics' positions are outside of the fuselage, then communication among commander, pilots and crew must be accomplished by special devices.

C. *Pilots' Positions*—Duplicate flight controls must be fitted so that they can be operated singly or simultaneously by both pilots. The flight controls must be arranged so that even in most unfavourable weather they can be operated by a man of average strength. Hand and foot controls must be constructed of non-magnetic materials in order not to influence the compasses.

D. *Engine Room and Flight Mechanics' Position*—The single (or multiple) engine-rooms must be large enough and the engines installed in such a manner that they are accessible in flight for service and repair of parts such as spark plugs, valve springs, exhaust flanges, carburettors, oil gauges, oil check-valves and water pumps. The flight mechanics' positions shall be near the engines; all instruments and valves shall be mounted close together, easy to operate and readily visible.

E. *Machine-gun Positions*—The following guidelines must be observed: combined fire of as many guns as possible in any direction, and the zone below the tail must be protected.

F. *Bombardiers' Position*—This position should be placed as near to the nose as possible. The bomb-release mechanism must be fitted so that it can be operated by the bombardier while aiming the bomb-sight.

G. *Bomb Bay*—In order to save weight, the internal structure of the fuselage may be advantageously used to support the bomb racks. The bomb bay shall be equipped with outward-opening, self-closing spring doors. The bomb-release mechanism shall enable bombs to be dropped singly or in salvos. The bomb bay must be accessible during flight to permit checking of the release mechanism, to de-fuse the bombs and to release bombs by hand in an emergency.

II. *Engines*

A. *Engines and Transmission*—The engines must be mounted in a manner so that they can be installed or taken out as a whole. Hoisting and sliding devices must be provided for this purpose. Equipment must be installed to permit starting and stopping the engines in flight from the flight mechanics' position. Self-starting devices must be provided.

Special care must be taken in mounting the engines. If the engine is geared, the gear housing must be rigidly bolted to the engine housing or jointly supported on a common engine bearer. When engines and gear-boxes are mounted separately, they shall be connected by elastic couplings. Likewise, the transmission shafts between engine and propeller gear-box shall be equipped with elastic or universal couplings. The revolutions of propeller transmission shafts shall be kept low to avoid resonance oscillations. If several engines are connected to one gear-box they must be equipped with clutches to permit starting or

stopping any engine. Friction clutches must be protected against oil. For the preservation of gear teeth and conservation of uniform rotary movement, the engines shall have flywheels, or the clutches must be built as such.

The gear-oil temperature shall not exceed 80° C even in hot weather, otherwise forced oil cooling must be employed. For control of gear-oil temperature, each gear-box shall be fitted with one mercury and one thermo-electric thermometer. Engine and gear spaces must be well ventilated so that the efficiency of the flight mechanics is not impaired by oil fumes, steam or exhaust vapours.

B. *Attendance of Engines*—Throttles and master ignition switch must be capable of being controlled separately or in unison from the pilots' position. Independent throttles, starters and ignition switches must be provided for the flight engineers. The starting devices, clutch levers, oil and fuel valves and hand pumps shall be located in the flight mechanics' position.

C. *Fuel Tanks*—There shall be two emergency tanks (gravity or pressure tanks) and several main tanks. Larger fuel tanks must be divided into several compartments. Each tank or compartment shall have shut-off valves.

D. *Exhaust Pipes*—Exhaust pipes must be constructed to minimize noise and to trap flying sparks and exhaust flames without becoming red-hot. The exhaust pipes must be mounted outside the airframe. Each exhaust pipe shall have an operating life of sixty hours.

E. *Radiators.*—Radiators must be so proportioned and arranged that, even in the summer, engines may be run at full throttle on the ground for 5 minutes without the cooling water coming to the boil. Controls must be provided to enable the flight mechanics to maintain a water temperature of 60–75° C during flight.

III. *Internal Installations*

A. *Instruments*—All instruments must be protected from vibration. A calibration chart shall be fastened beside each instrument. The revolutions of propellers and engines shall be made known to the crew. The temperature of the cooling water of each engine and of the gear-box oil must be indicated to the pilots by electric thermometers and to the flight mechanics by mercury thermometers.

Communication between pilots and flight mechanics shall be kept as simple as possible. Repeating engine telegraphs, high-voltage transmission and pneumatic tubes come into question. As a means for indicating course, a suitable device should be provided for the pilots and the bombardier in the bombardier's position. An alarm device for warning the crew shall be mounted in the commander's position.

The following instruments must be installed in the pilot's position: two airspeed indicators, one variometer for measuring altitude, one artificial horizon for longitudinal and transverse altitude indication, two altitude recorders, one tachometer for each engine, one course indicator, one drum compass, one clock, one electric thermometer commutator switch.

A bearing compass shall be installed at the commander's position so that visual bearings can be taken in many directions. The floats in the fuel tanks shall be installed so that the fuel gauge reads correctly even when the aircraft is not in horizontal position.

B. *Wireless Equipment*—The wireless equipment shall consist of: one 1·5 h.p. petrol engine driving a 1000-watt (50-volt 20-ampere direct current or 150-volt, 7-ampere alternating current) generator, one R-transmitter/receiver, condenser, aerial reels and associated equipment. The wireless generator shall also be connected to the lighting, heating and electric bomb-release circuits. It may also serve as additional power for the electric starting of the engines. An emergency lighting and bomb-release source must be installed in case of main generator failure.

C. *Other Installations*—Cases containing oxygen apparatus, fire extinguishers, first-aid equipment, repair supplies and tools shall be located at easily accessible places. The wireless and flight mechanics' positions shall be equipped with the necessary emergency repair tools. In the commander's position a map table and seat shall be provided.

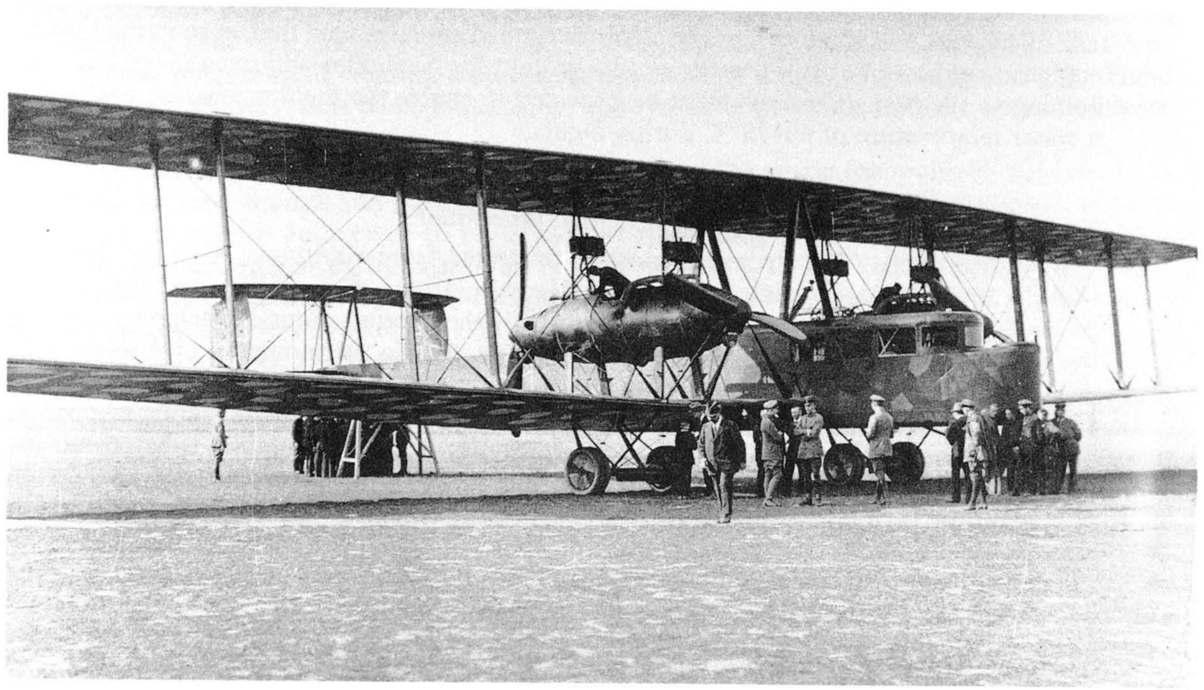
IV. *Acceptance Flights*

The senior officer of the acceptance commission and the manufacturer shall choose a day and time for the acceptance flights. The first flight shall consist of an endurance and maximum load flight. The greatest horizontal speed shall be recorded at the prescribed altitude, and bombs shall be released during this flight. The second flight shall determine maximum altitude and climbing speed under full load. Both flights may be combined as one.

The aircraft shall be flown by a company pilot, and the acceptance commission shall take positions of its own choosing. The commission shall weigh carefully all loads, determine the quantity of fuel and install its own altitude measuring instruments.

V. *Final Acceptance of the Aircraft by the Army*

After completion of successful acceptance flights, the commission will provisionally accept the aircraft from the manufacturer. Final acceptance by the Army shall take place after the acceptance and inspection records have been signed by the Chief of the Air Service; when all supplemental and reserve parts have been delivered and modifications ordered by the commission have been executed.



Staaken R.VI(Av) 33/16 being inspected by an Idflieg acceptance team at Leipzig.

There is one requirement in the BLVR which put the R-plane in a class by itself, apart from all other German aircraft, and which, to a great extent, determined the size and configuration of the R-plane. This unique requirement specified that an R-plane's engines must be fully accessible, serviceable and capable of being repaired *in flight*. It can be shown that virtually all other BLVR specifications could apply to aircraft of other classes (i.e., duplicate controls, wireless equipment, geared engines, etc.), but the in-flight accessibility provision was an exclusive feature of the R-plane, and was the primary characteristic by which an R-plane's classification was determined.

From the outset the R-plane was intended as a long-range bomber capable of carrying heavy bomb loads and large quantities of fuel. To perform its long-range mission successfully an infallible power plant that would operate for many hours without failure was imperative. Contemporary aircraft engines were not sufficiently reliable to meet this demanding endurance requirement. As a solution to their problem, R-plane designers followed the example set by airships; they made the engines accessible in flight so that they could be serviced or repaired if the need arose. This in turn required large engine-rooms or spacious nacelles and large aircraft to permit a mechanic to move freely while attending the engines.

A second characteristic of the R-plane, implied but not detailed in the specifications, was its great load-carrying ability. To lift bombs and fuel and to furnish reserve power in case of engine failure, all R-planes were by necessity equipped with three or more engines. The principle of in-flight accessibility and multi-engined power were instrumental in saving a number of R-planes which might otherwise have been lost. Here are several instances quoted from combat reports:

Staaken R.VI(Av) 33/16 reported that during an attack on London both engines in the port nacelle began to fail, the front engine finally stopping altogether. The cause was traced back to oil congealed by low temperature. By cutting open the oil tank and filling the engine by hand, it was possible to prevent a forced landing in the Channel (16/17 February 1918).

Staaken R.VI 25/16 reported that the port rear engine lost cooling water because of a broken hose clamp. It was possible to repair the leak and the engine continued running at reduced r.p.m. A short while later the engine lost several exhaust headers and the exhaust flames caused the oil tank covering to catch fire. The fire was extinguished, but the engine had to be stopped. The R.25 returned safely.

Staaken R.V 13/15 reported a broken valve spring and that the valve was lifted by hand during the return flight so that the engine again ran smoothly.

Staaken R.VI 31/16 reported that the port rear engine stopped on approaching the target owing to faulty lubrication, but the flight over the target was nevertheless completed.

Staaken R.IV 12/15 reported that the port nacelle gear-box broke and caught fire, which was extinguished in flight. A perfect landing was made in spite of stopped port engines.

During a 10-hour endurance flight the valve rocker arm of a Navy Staaken seaplane was replaced.

Although the principles of in-flight accessibility and multi-engine power were common to all R-planes, their designers were divided into two schools regarding which engine and airframe configuration was the optimum. One group believed in the superiority of decentralized power units for R-planes while the other favoured centrally or internally powered machines. The wide range of R-planes, proposed or built, is proof that R-plane design was in a constant state of flux and that the ultimate configuration had still not been found by the end of the war.

Decentrally-powered R-planes were characterized by one or two engines mounted in port and

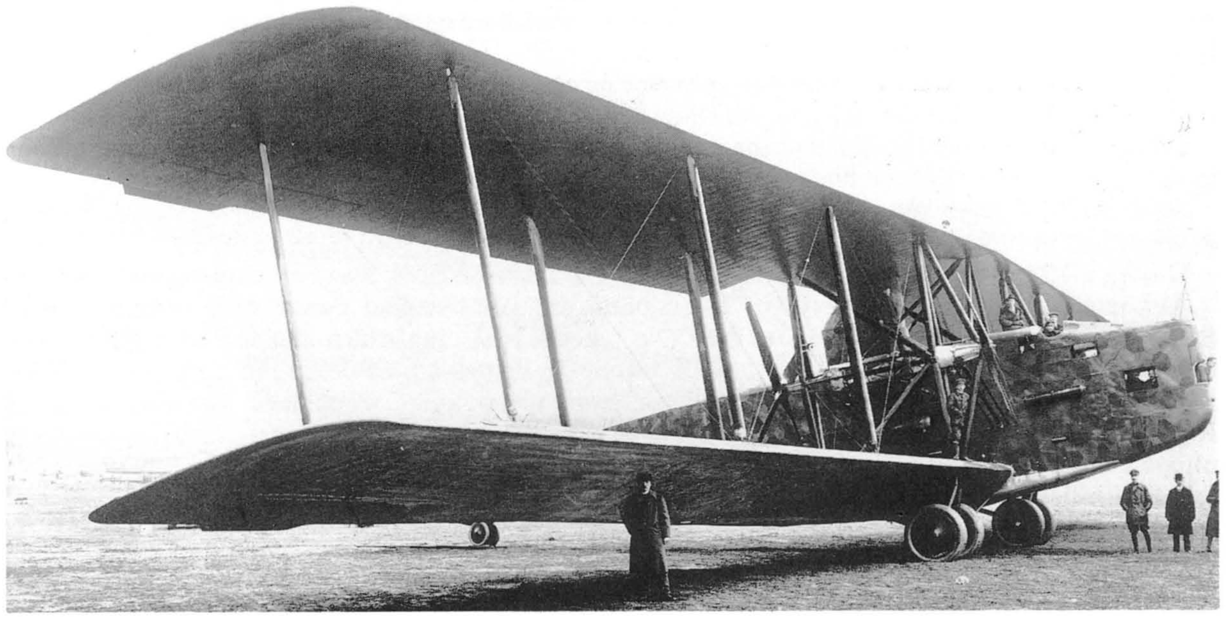
AEG R.I. A centrally-powered machine with four 260 h.p. Mercedes D.IVa engines.

starboard nacelles, and in some cases an additional one or two engines mounted in the fuselage nose. This configuration, used by Staaken, proved to be a fairly uncomplicated and reliable arrangement.

Centrally-powered R-planes were those in which the engines were concentrated within the fuselage. These engines were coupled to one or more common gear-boxes and drove from one to four propellers through a system of clutches, transmission shafts and gears. The centrally-powered formula was very flexible, with the result that many different designs were produced.

Both engine configurations possessed certain advantages and attendant disadvantages which should be understood in order to comprehend the reasons behind the various designs and why they failed or succeeded.

In theory, centrally-powered R-planes seemed superior because of the more favourable location of the engines. The weight of the engines was concentrated near the centre of gravity, which increased manoeuvrability and lowered the steering forces about the longitudinal axis. As a result, the flight characteristics of the centrally-powered R-planes were usually quite good. The internal location of



SSW R.VIII. This was powered by six centrally located 300 h.p. Basse und Selve BuS.IVa engines.

the engines made it possible to communicate vocally with the crew. Furthermore, only one flight mechanic was required in most cases to service the centralized engines. The fuselage protected the mechanic from the elements, making his task easier.

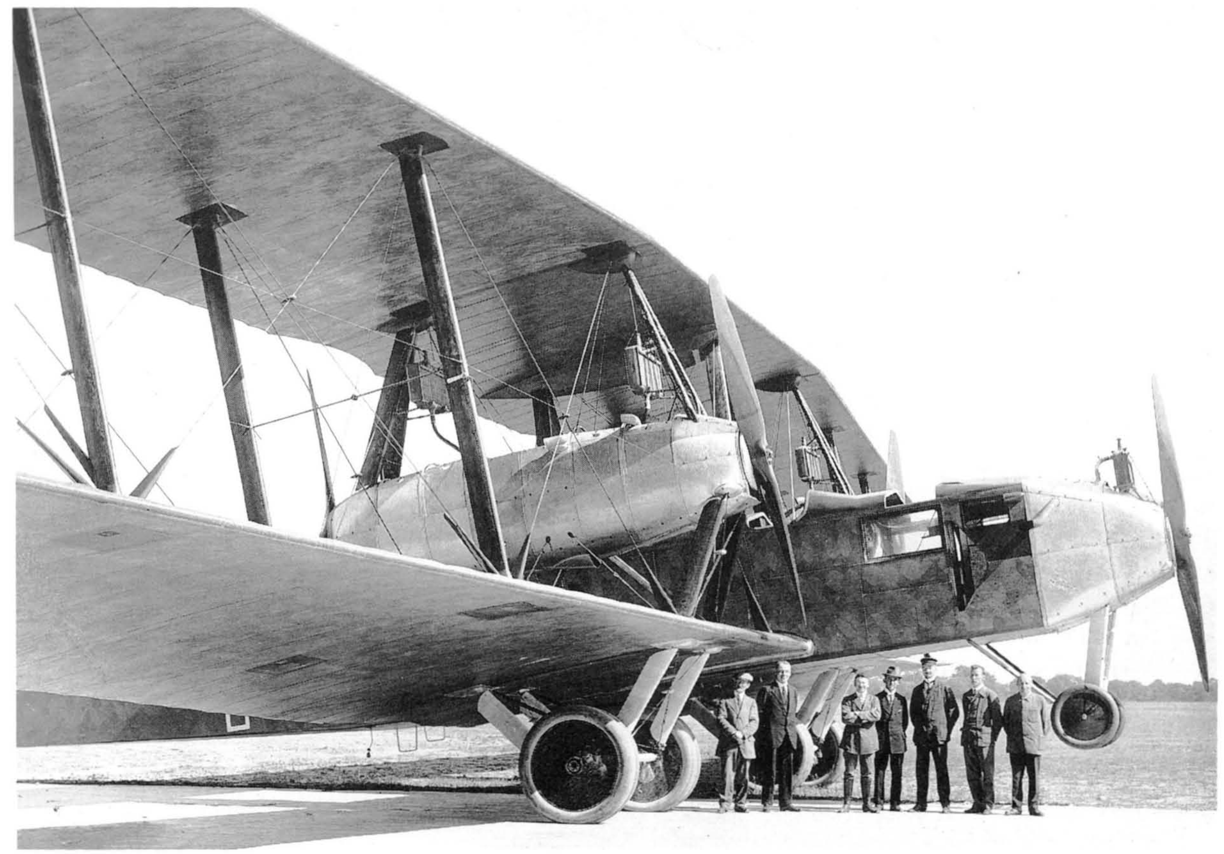
From a design standpoint, the engineer was not restricted as to the number and location of the propellers so long as the length of the transmission shafts remained reasonable. In the early days of R-plane design it was thought that the major advantage of the centrally-powered designs was the avoidance of an asymmetric flight condition due to engine failure. For example, if two propellers were driven from a common gear-box which was coupled to three or four engines the failure of one engine would decrease propeller revolutions, but the propellers would continue to operate at equal, if reduced, thrust, and thereby maintain a symmetrical flight condition. However, the Staaken R-planes showed that the failure of all the engines in one nacelle did not present the hazard as was originally thought. By proper control setting and throttling back the opposing engines, straight flight could be maintained.

Central engine installations proved, in practice, to be riddled with unforeseen problems that were to plague these types throughout the war.

Because the drive and transmission components represented dead weight, an effort was made to keep them and the airframe as light as possible. The result was that the gear drives were very sensitive and required careful and continual servicing, often an impossibility under operational conditions. Misalignment of the engine and drive assemblies, due to the lightness of the airframe and shifting engine mounts, caused frequent mechanical failures. Eventually many of these problems were solved at the expense of heavier mechanical parts, reinforced integral engine mounts, stronger airframes and complex flexible couplings, all of which subtracted from the aircraft's useful load. One unavoidable disadvantage was the reduction of propulsive efficiency due to power absorbed by the gears, which further detracted from the performance of centrally-powered R-planes.

Although the various internal drive systems were exhaustively tested on the ground in special test fixtures, their operation in an aircraft was a different matter entirely. Flight testing and modification of the complicated drive systems took time, and consequently the development of operational machines was delayed. Indeed, none were sufficiently advanced in performance to partake in operations on the Western Front. For instance, the Siemens-Schuckert R-planes were ultimately quite reliable, but their rate of climb, ceiling and load-carrying capacity never did compare with the Staaken types, and their operational career was limited to the less-active Eastern Front.

On the other hand, R-planes with decentralized engines, as exemplified by the Staaken bombers, were the mainstay of the R-plane squadrons on the Western Front. Their primary advantage was the elimination of cumbersome and easily-damaged transmission components. Rather, each engine drove an individual propeller through a reliable and simple reduction gear-box which was actually part of the engine. This simplification significantly increased reliability. The reduction of power plant and engine-bearer weight and the more favourable distribution of engine, fuel and bomb loads made it possible to reduce the airframe weight, all of which increased the useful load of the aircraft.



Staaken R.XIVa (Schül). Example of decentralized power arrangement with five 245 h.p. Maybach Mb.IVa engines.

Port nacelle of the Staaken R.IV. This view shows mechanics in attendance during flight.

Staaken did construct several R-planes with two engines coupled to a single propeller, but, with the exception of the long-lived Staaken R.IV, this configuration was not entirely successful.

The disadvantages of the Staaken types did not prove as serious as envisaged. Although each engine position required a separate flight mechanic, which in the case of a five-engined R-plane totalled three men, they also doubled as machine-gunners. The flight mechanics had to be highly-trained and skilled to react almost automatically to any emergency. Communication to the engine nacelles was difficult and slow, and only standard messages could be transmitted by the engine telegraph. Climbing over the wings to deliver a message was recommended only in times of grave danger. Although the fear of unequal thrust in case of engine failure was unfounded and did not prove a problem, the greater distance of the engines from the central axis did have an adverse effect on flight characteristics, but this was easily mastered by an experienced pilot. Actually the separated engines provided an unforeseen advantage, for it was demonstrated that the Staaken machines could be manoeuvred by throttling-back port or starboard engines, a procedure claimed to be useful in gusty weather.

In the final analysis it was the separated engine configuration of the Staaken R-planes, with its simplicity and greater reliability, that proved superior. Although internally-engined R-planes were still under construction at the war's end, the R-plane squadrons would undoubtedly have been equipped with decentrally-powered R-planes had the war continued. Indeed, the majority of the advanced projects were designed around separated engines, as demonstrated by the Staaken E.4/20, a civil version of a wartime bomber project.

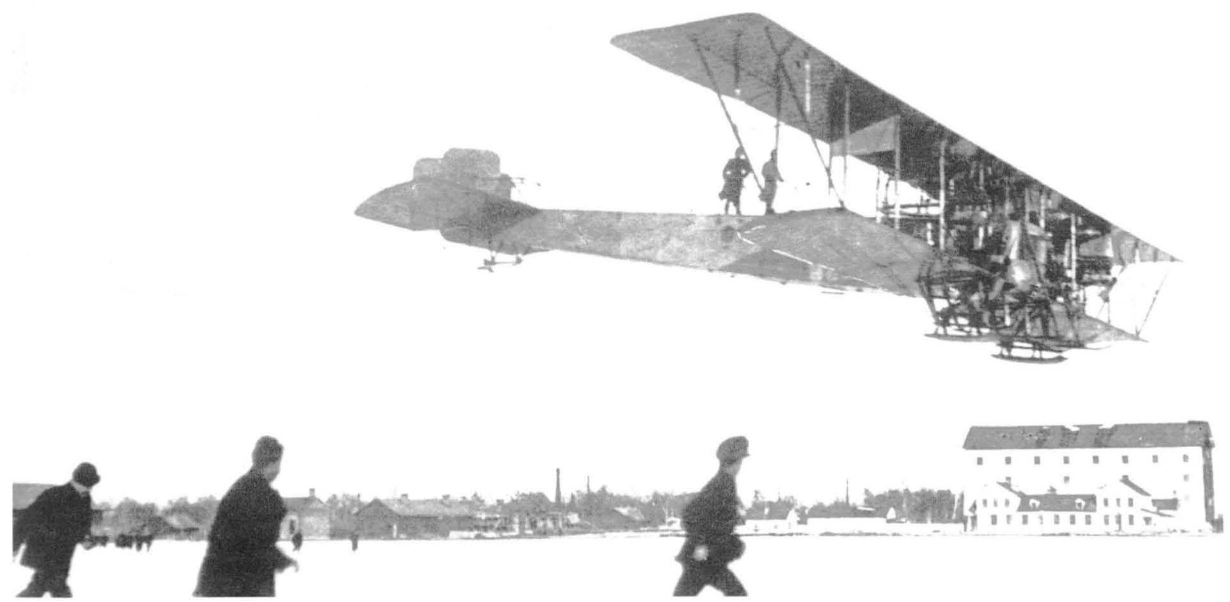
Operational History

The R-plane, the largest aeroplane of World War I, was conceived as a long-range strategic weapon for attacking objectives deep within enemy territory. Contrary to its World War II counterparts, the R-plane was produced only in small numbers. It is estimated the Germans built between fifty-five and sixty-five R-planes and, of these, some thirty reached the Front. The fate of the remainder varied; some crashed before delivery to the Army; the older machines were relegated to training duties; others were obsolete before engineering problems had been resolved, and a small number were on the verge of entering operational service when the war ended.

The operational history of the R-plane spanned the years 1915–19, from its baptism of fire on the Russian Front to its swan song as a transport to the Ukraine. In its infancy the development of the R-plane as a long-range weapon was eclipsed by the airship, a highly-publicized "terror" weapon under whose shadow Europe cringed. At the beginning of the war the airship was at the peak of its military popularity, its future not yet clouded by the grievous losses soon to come. With the weight of Prussian military opinion squarely behind the airship, dedicated individuals were required to stand firm in support of the R-plane. A few far-sighted men did, among them Graf Zeppelin, Gustav Klein, Admiral Dick of the Navy and Oberst Thomsen and Major Siegert of the Army. These men sincerely believed in the potentialities of the giant bomber and recognized its advantages over those of the airship. They enthusiastically supported R-plane development which the airship-oriented War Ministry viewed with mistrust and scepticism. In spite of man-made barriers and difficult technical obstacles, the first R-planes of Staaken and Siemens-Schuckert flew and in time did so with a measure of success that not even the War Ministry could disregard.

The "Ilia Mourumetz" bombers were already active against the Germans on the Eastern Front. While former R-plane personnel claim that these aircraft did not influence the development of German R-plane operations, it is difficult to dismiss the "Ilia Mourumetz" type entirely. Certainly it showed the Germans what could be done in the way of long-range bombing, even if the aircraft were not as effective as the Russians thought.

As the new R-planes began to demonstrate their military potential, the faith in the airship's superiority slowly began to fade and the once-negative attitudes of the Prussian War Ministry and High Command towards the R-plane changed to one of increasing enthusiasm. By late 1915 the



Sikorsky's first "Ilia Mourumetz" on a test flight during February 1914.

R-plane was accepted and given a permanent status in the German war machine as a logical successor to the "strategic bomber" concept represented by the airship.

The department responsible for Army aviation, the Inspektion der Fliegertruppen (Idflieg), established the Riesenflugzeugersatzabteilung[1] on 29 April 1916 to centralize and give guidance to an ever-increasing R-plane effort. The Rea was based at the large air park and flying establishment in in Döberitz, near Berlin. The newly-formed Rea, from 1916, under the command of Rittmeister Hans Frhr. von Könitz, was composed of an officer and engineering staff, an inspection branch and a training command. The duties of the Rea included inspecting aircraft factories, training specialists and crews, acceptance testing of R-planes, evaluating front-line experience to pass on to the factories and supplying the R-plane squadrons with material and personnel. By 1918 the Riesenflugzeug Truppe (R-plane Troops) had greatly increased in size and scope. Details of its organization are outlined in Appendix 2.

EASTERN FRONT OPERATIONS

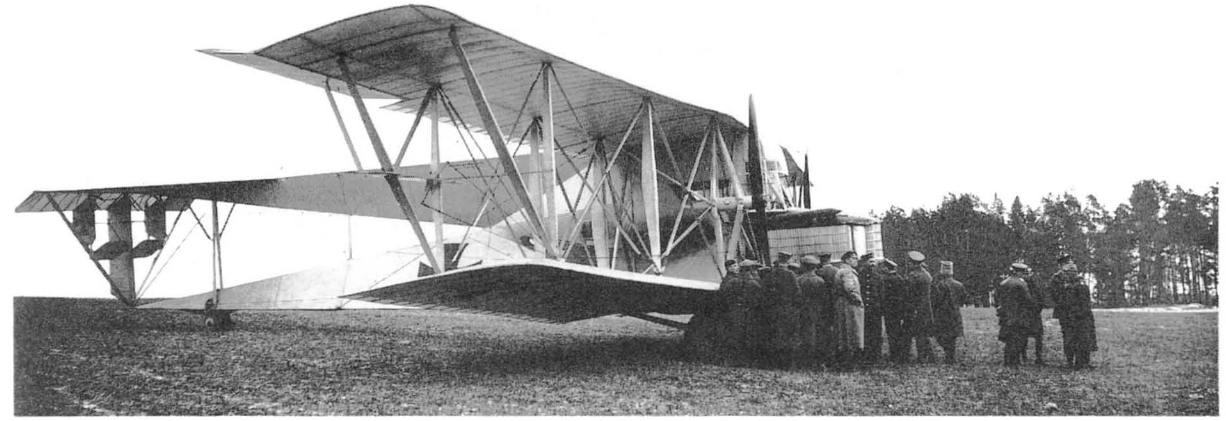
As soon as the first R-planes, built by Staaken and SSW, were considered ready for operational deployment, they were flown to the comparatively quiet (from the air war point of view) Russian Front, where two new R-plane squadrons were established. A contemporary squadron report has stated that these early R-planes were in no way equal to the task set before them. Their performance, notably climb and ceiling, would have made them "sitting ducks" on the Western Front, but on the Eastern Front the performance requirements were less stringent. Even so, Russian anti-aircraft measures (guns and aircraft) were sufficiently powerful to force the low-performance, low-flying R-planes to seek the cover of darkness very early in their service career.

The SSW R.I 1/15 which was evaluated on the Eastern Front.

During the early phase of R-plane operations the principal objectives on the Eastern Front were the Russian military installations on the islands of Oesel and Runö and along the coastline of the Gulf of Riga.[2] Other targets were the city of Riga and installations behind the Russian Front, especially large troop encampments, marshalling yards and supply dumps. Because early navigation was all done by visual sighting, targets were invariably located near easily identifiable landmarks such as coastlines, lakes, railroad tracks, rivers and islands. The average bomb load on these missions varied between 880 and 1700 lb.; the aircraft flew at between 6500 and 7800 feet and the flight duration was from 3 to 5 hours. In comparison, the more powerful R-planes which later flew on the Western Front carried an average bomb load of 2500 lb., flew between 8200 and 11,500 feet and stayed aloft from 4 to 7 hours.

[1] Rea—R-plane Support Section.

[2] Towns and place names on the Eastern Front are generally referred to by their German spelling as taken from official reports and documents. Many of these locations now exist under changed names.



SWW R.I 1/15 at Bialystok aerodrome (F.Fl. Abt.2) on the Eastern Front 1915.

Although these early R-planes did attack numerous targets behind the Russian Front, they functioned primarily as experimental and training aircraft. As such they performed a valuable service, providing a wealth of information upon which the design of future R-planes was based. At the front and at home factory representatives and military personnel co-operated closely through Rea to find solutions to the many problems exposed by the harsh conditions of front-line service. From an operational standpoint, a host of new techniques, such as wireless communications, bomb-aiming and night and cross-country navigation procedures, were developed by officers and crews of the R-plane squadrons. These men formed a cadre for the second-generation R-planes that were to go in service on the Western Front in 1917.

The sequence of events leading to the organization of the two Riesenflugzeugabteilungen (Rfa 500 and Rfa 501) is difficult to trace because the Rfa's were not established along definite lines but rather grew into shape as R-planes became available for front-line service.[1] Rfa 501 began as an offshoot of Feldfliegerabteilung 31 (Field Aviation Squadron 31) in the autumn of 1915, when Idflieg requested that this squadron provide a Sonderkommando (Special Command) to take delivery of the SSW R.I 1/15 in Berlin. Oblt. George Krupp was selected to command this group which was to become the nucleus for Rfa 501. Very little was known about these new R-planes, and they were altogether a new experience to men of the air service. Obviously Krupp was confronted by innumerable problems, and his task was a challenging one. He had to assemble a crew and ground personnel, learn how to fly and service the new bomber, establish ground handling procedures, procure supplies and provide front-line hangar space. Work to solve these and a thousand other problems was started while the Sonderkommando was waiting for the R.1 to be accepted. However the R.1 crashed in Johannisthal, and Krupp and his crew returned to Fl. Abt. 31 in Slonim. In late September 1915 the repaired R.1 was flown by Krupp to Slonim via Posen, Warsaw and Bialystok. In Warsaw the R.1, grounded due to heavy rains, had to be left in the open. Twenty-four hours later, the R.1 could not be made to leave the ground, but the reason was not immediately clear until Ing. Rau poked his bayonet into the undersides of the top wing. Gallons of rain water gushed out. Shortly before reaching Bialystok, a transmission coupling broke and the flailing transmission shaft forced Krupp to land. This time a special tent was brought from Slonim and erected over the R.1 for protection. The R.1 finally reached Slonim about 13 October 1915, but was never able to execute any bombing raids. In March 1916, after several mishaps including a broken undercarriage, it was considered unsuitable for front-line service and shipped back to Berlin. Thus ended the first attempt to begin R-plane operations on the Eastern Front.

In the meantime on 1 February 1916 Rfa 500 was established at Alt-Auz[2] under the command of Rittmeister Frhr. von Könitz (prior to his taking command of Rea). Within a few weeks the VGO.II,

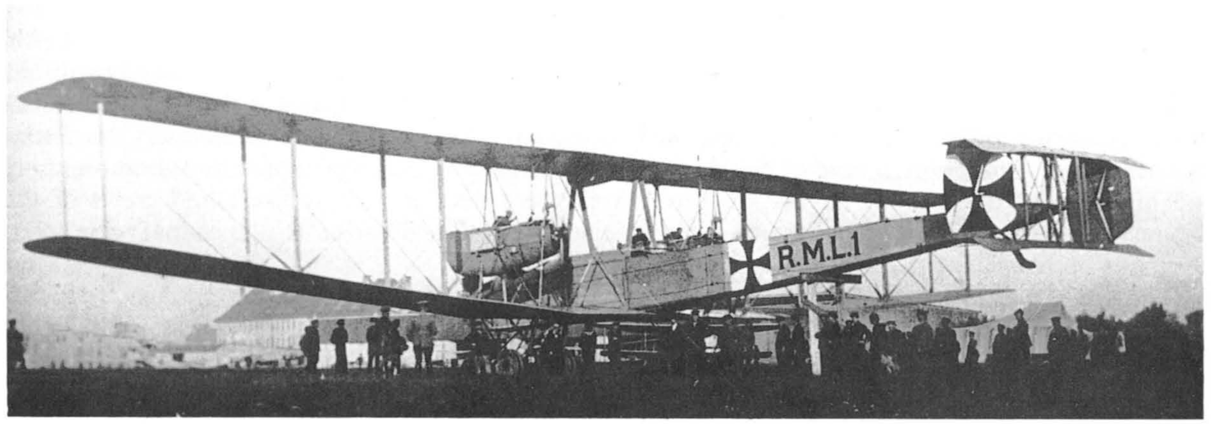
[1] Rfa 502 and 503 were officially approved on 28 December 1916 in the German military budget for 1917, but were never formed, since R-plane production was not sufficient to equip more than two squadrons.

[2] Now Vec Auce in Latvia.

first of the Staaken R-planes accepted by the Army, was delivered to Alt-Auz, and according to an article written by Offiziersstellvertreter (Acting Officer) Selmer, it made its first night-bombing raid in March. However, this information conflicts with official German records that the attack of 13 August 1916 by Oblt. von Hallerstein in the VGO.II was the first successful bombing raid by an R-plane.[1] This later date is more acceptable; because of the experimental nature of the night-bombing equipment, the time required to work out a host of new operational techniques and the recurrent failures and replacements of the Maybach HS engines, the VGO.II probably required all of five months to achieve its first proven success.

By the time the VGO.II was operationally ready, Rittmeister von Könitz had assumed command of the Rea and Oberleutnant Frhr. Haller von Hallerstein had taken over command of Rfa 500. The objective for the first successful R-plane attack was the rail junction at Schlok (near Angernsee, Estonia) which the VGO.II was to have attacked in concert with the RML.1 (VGO.I), the Navy's land-based R-plane.

Fortunately, the war diary of the Kommando L.R.I, a special Naval detachment stationed alongside Rfa 500 at Alt-Auz, has been preserved. The Navy was interested in evaluating the land-based R-plane as an addition to their airship force for bombing and long-range scouting duties.



The RML.1 as used on operations over the Eastern Front.

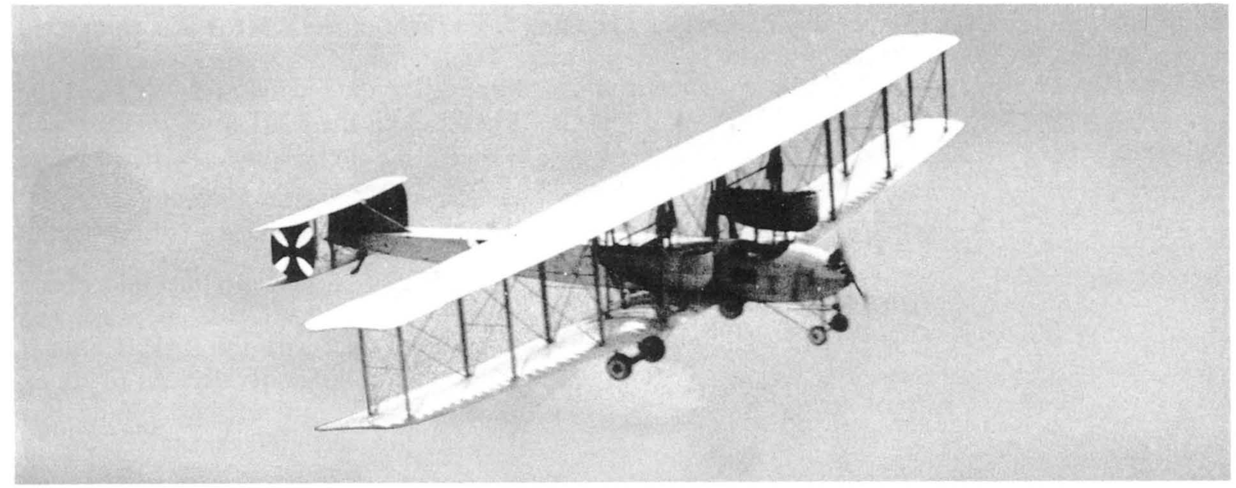
Consequently, the rebuilt RML.1 (VGO.I) was flown to Alt-Auz by Navy personnel under the command of Lt. z. See Ferdinand Rasch.[2] The war diary, a valuable fragment of early R-plane history, provides an interesting account of what an early R-plane mission was like and illustrates the type of problems encountered during service evaluation of the new weapon. Although the exact date of arrival of the RML.1 on the Eastern Front is not known, it is presumed that its operational life coincided with the time span of the war diary, which ran from 12 August to 24 August 1916.

Flight Report No. 1, stated that a joint attack by both R-planes (Army and Navy) was scheduled for 12 August, but was postponed because of heavy ground fog. On Sunday, 13 August, both aircraft took off at 19.15 hours to raid the railroad junction at Schlok. The RML.1 approached a thick cloud bank north of Alt-Auz which it could not surmount. It had already taken one full hour to climb to 1400 metres because the nose engine, leaking water, was incapable of supplying full power. The commander decided to return to the base, leaving the VGO.II to fly on alone. After landing, it was found that a cylinder and piston head had cracked; repairs were completed by 19.00 hours on 14 August, when the RML.1 was reported ready for operational duty again.

On 15 August orders were received to attack Runö, a small island in the Gulf of Riga, in order to divert attention from a German seaplane tender which was to anchor there during the night. Rasch, the commander of the RML.1, decided to combine this maiden attack with a raid on Schlok. The RML.1 was loaded with 500 kg. of bombs consisting of 6 × 50 kg. (Karbonit type), 8 × 20 kg.

[1] Contrary to what has been reported in *Riesenflugzeuge* by Offermann, the VGO.III did not perform the first R-plane raid, since it did not join Rfa 500 until 8 September 1916.

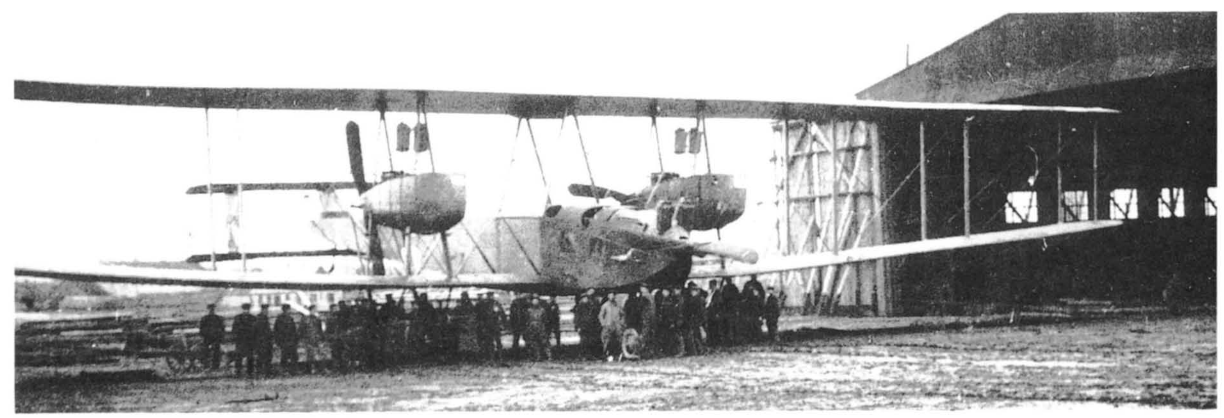
[2] Lt. Rasch later became a director of the Zeppelin-Werke in charge of the R-plane department.



VGO. II 9/15. Officially credited with being the first R-plane to perform a successful bombing raid. Photo dated 5 November 1915.

(Karbonit type) and 4 × 10 kg. incendiary bombs (Goldschmidt type) and 1200 litres of fuel sufficient for 5½ hours flight. The RML.1 took off at 00.45 hours. Almost at once, the nose engine stopped because it had not been properly warmed and the left engine boiled over, but altitude was maintained as the RML.1 circled the airfield until all engines again ran smoothly. The RML.1 then flew to Schlok via Mitau along the River Aa. It reached the objective at 02.35 hours and proceeded to drop 6 × 50 kg., 3 × 20 kg. and two incendiary bombs from an altitude of 2000 metres. A great fire, thought to be a burning timber yard, was later visible to the crew from a distance of 100 km. During the attack, which was carried out in full moonlight, the railroad tracks and installations were clearly visible to the naked eye, but even so, the bomb-aiming telescope proved a failure. In all probability it was an adaptation of a day telescope and lacked sufficient light-gathering power to pick out targets at night. The commander recommended that night approaches be made visually, using the aiming telescope only at the last moment after the correct sighting angle had been set by eye.

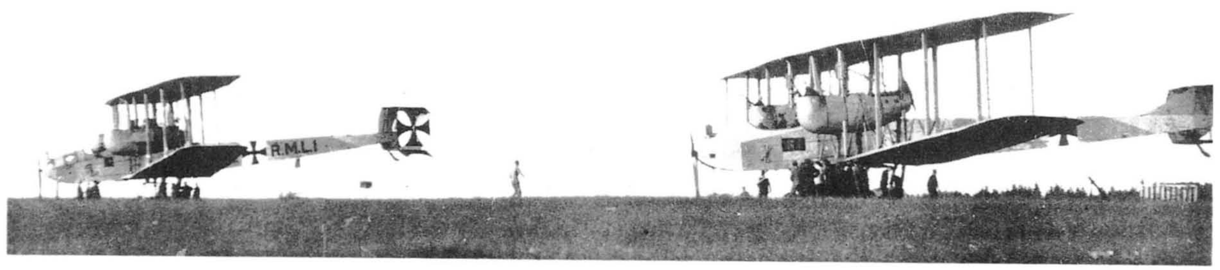
The RML.1 continued on its course, flew out over the Gulf of Riga and crossed Runö Island at 04.00 hours. Neither the German seaplane tender nor any other surface craft were spotted in the darkness below. The RML.1 turned back, and just before it flew over Runö again a vessel was sighted which got under way as the bomber approached. It was possible to catch the vessel in the bomb-aiming telescope and 5 × 20 kg. bombs were released. No hits, only heavy white smoke clouds, were observed. As the bomber crossed Runö for the second time, two of the new Goldschmidt incendiaries were dropped into the forest to observe their effect, but only one bomb ignited with a small flame that soon died out. On leaving Runö, the rear machine-gun crew reported a seaplane



The VGO.III on the tracks outside its hangar at Alt-Auz, summer 1916.

taking-off, but it quickly disappeared from sight. The first front flight of the RML.1 was completed when it landed at Alt-Auz at 05.20 hours.

Flight Report No. 2, dated 16 August, stated that the objective for the second raid was to be the Russian seaplane base at Lebara, a round trip of 360 km. For the raid, the RML.1 was loaded with 3 × 50 kg., 18 × 20 kg. and 6 × 10 kg. incendiary bombs and 1100 litres of fuel. At 01.30 hours the bomber took-off in full moonlight, and by 03.30 hours it had gained an altitude of 2400 metres. As the bomber flew along the coast it was spotted against the dawning north-east sky and was fired on by Russian land-based and shipboard anti-aircraft guns. The commander had to make the choice of whether to swing out to sea, turn around and attack from the north-east, or to turn inland and approach the coast from a dark south-east sky. The disadvantage of the south-east approach was that it would give Russian aircraft ample time to climb and make contact with the RML.1 after it had turned and was recrossing the coast on its homeward flight. The commander decided to attack from the north-east. Although he ran the risk of being spotted by the anti-aircraft batteries against the light sky, this was the homeward course, and Russian aircraft would have little chance of catching the RML.1.



The RML.1 and the VGO.II on the airfield at Alt-Auz.

As the RML.1 crossed the coast from the north-east the blacked-out Lebara seaplane station could not be located, but several bombs were dropped in the vicinity, and here the RML.1 was again fired on by anti-aircraft guns. A few ships were sighted along the coast, among them two destroyers, and it was decided to attack these. At the same time four Russian seaplanes were spotted taking-off, two of which followed the RML.1. The destroyers were engaged in a half-hour running battle, and the RML.1 proved manoeuvrable enough to follow the vessels' evasive zig-zags and circles. Of the twenty-one bombs dropped no hits were recorded, although several bombs fell directly into the wake of the destroyers. During this attack one Russian seaplane had gained sufficient altitude to fire at the RML.1 from about 300 metres below, but it was driven off by defensive machine-gun fire. The RML.1 landed at 06.20 hours with shrapnel holes in the left upper wing and machine-gun hits in the nose engine exhaust manifold, the right upper wing and the elevator.

The aircraft commander made several comments based on this raid: (1) the anti-aircraft shells generally exploded well below the aircraft. Apparently the anti-aircraft crews incorrectly estimated the altitude of the RML.1 because of its great size; (2) successful night attacks are only feasible if the location of the target can be exactly pre-determined either from previous visual reconnaissance, air photographs or detailed charts; (3) the bomb-aiming telescope in its present form is inadequate for night attacks; (4) light sky and horizon should be avoided; (5) surprise night attacks on anchored ships are feasible, and (6) a bomb hit on a moving vessel is purely a matter of luck.

Flight Report No. 3, dated 17 August, listed the targets as the Russian air station on Runö and the troop encampment at Kemmern. The total flying distance was 330 km., of which 170 km. was over the water. The bomb load comprised 23 × 12 kg., 12 × 20 kg. and 17 × 7·3 kg. incendiary (Goldschmidt) bombs for a total of 640 kg., and 1050 litres of fuel (750 kg.) were carried for the mission. The take-off was at 01.22 hours on a clear and moonlit night, and by 02.40 hours the RML.1 had attained a height of 1900 metres. Over Kemmern the seventeen incendiary bombs were

The last landing of the RML.1 on the Eastern Front.

released, starting minor fires that were soon extinguished except for two which burned for twenty minutes. (Here in the war diary a Naval archivist had placed a short memorandum written by a staff officer who asked if an incendiary bomb having greater potency could be obtained.) The RML.1 flew on to Runö, where it was fired on by three moving ships. According to the report one vessel had a searchlight, but it failed to locate the aircraft. One wonders what the gunners were firing at if the searchlight crews could not locate the aircraft. In spite of the aircraft commander's previous conclusion that bomb hits on moving ships were a matter of luck, two of the ships were sighted in the bomb-aiming telescope and attacked with 20 × 12 kg. bombs from 2400 metres altitude. It was impossible to differentiate bomb hits (if any) from the gun flashes and searchlight beams, one of which finally caught the RML.1. Russian anti-aircraft shells still exploded well below the aircraft. A second attack was made on the ships with the remaining bombs and with several bursts of machine-gun fire. The air station at Runö was not attacked; presumably it could not be located in the dark. The RML.1 landed at 05.50 hours with three shrapnel holes in its wings.

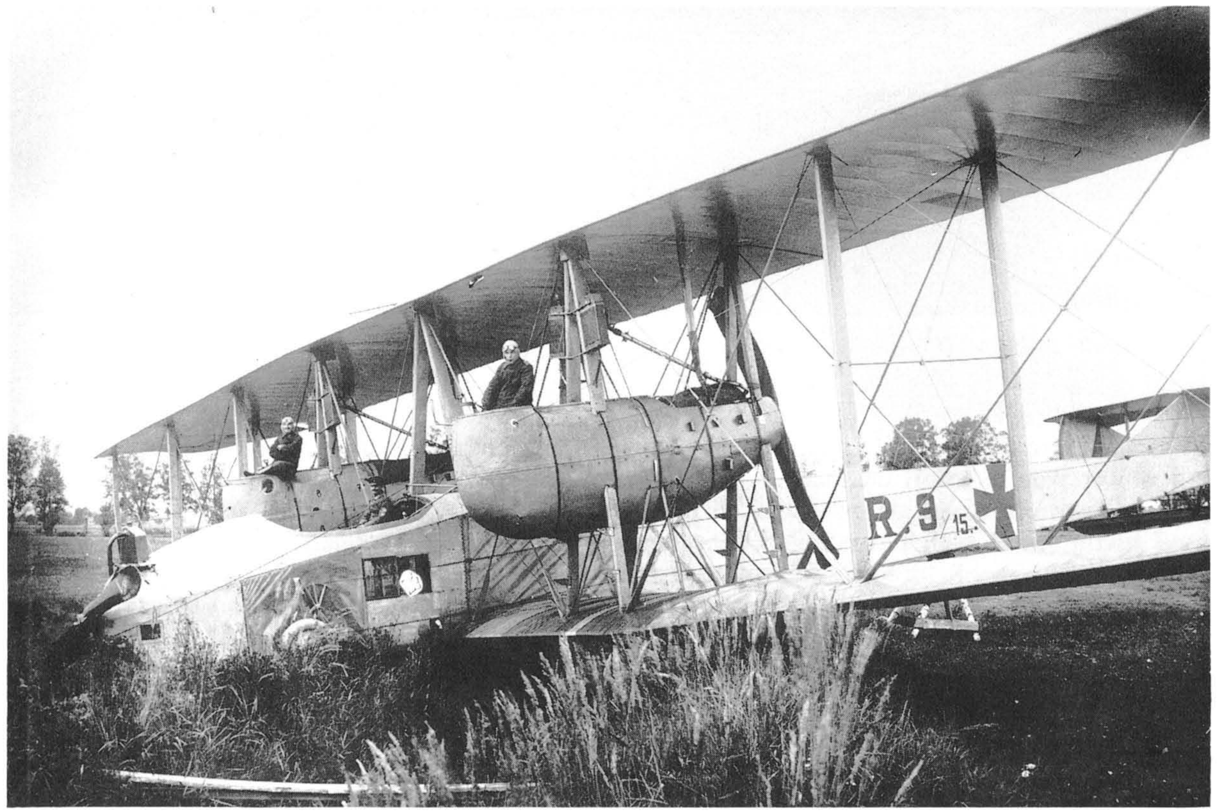
Rasch, the commander, made several additional recommendations and notations: (1) silencing of engines is strongly urged; (2) it is not as easy to evade searchlight and anti-aircraft fire with a giant aircraft as it is with smaller machines; and (3) spotting bomb hits on darkened ships at night is inconclusive because of the difficulty in differentiating among hits, searchlights and gun flashes.

Flight Report No. 4 describes the last operational flight of the RML.1 on 24 August 1916. The target, the troop encampment at Kemmern, was to be bombed with 21 × 20 kg., 32 × 12 kg. and 9 × 10 kg. incendiary bombs; the total load of 894 kg. was the heaviest bomb load carried by the RML.1. The 160-km. flight required 700 litres of fuel (500 kg.). The weather was $\frac{1}{4}$ to $\frac{1}{2}$ overcast with slight winds, and lightning flashes were to be seen in the distance. The unfavourable weather did not permit a bombing mission of greater range that night. The RML.1 took-off at 03.30 hours, but once in the air the port engine began to boil and continued to do so even at reduced throttle. The flight was cancelled and the machine landed at 04.30 hours. The RML.1 was reported ready again for operational duty on 25 August. This was the last entry in the RML.1 war diary. The war diary of the Kommando L.R.I. ended followed by a short telegram dated 1 September 1916 stating that "in

the meantime the RML.1 has been damaged". The remains of the machine were shipped home and rebuilt. (See VGO.I-RML.1 Chapter for details.)

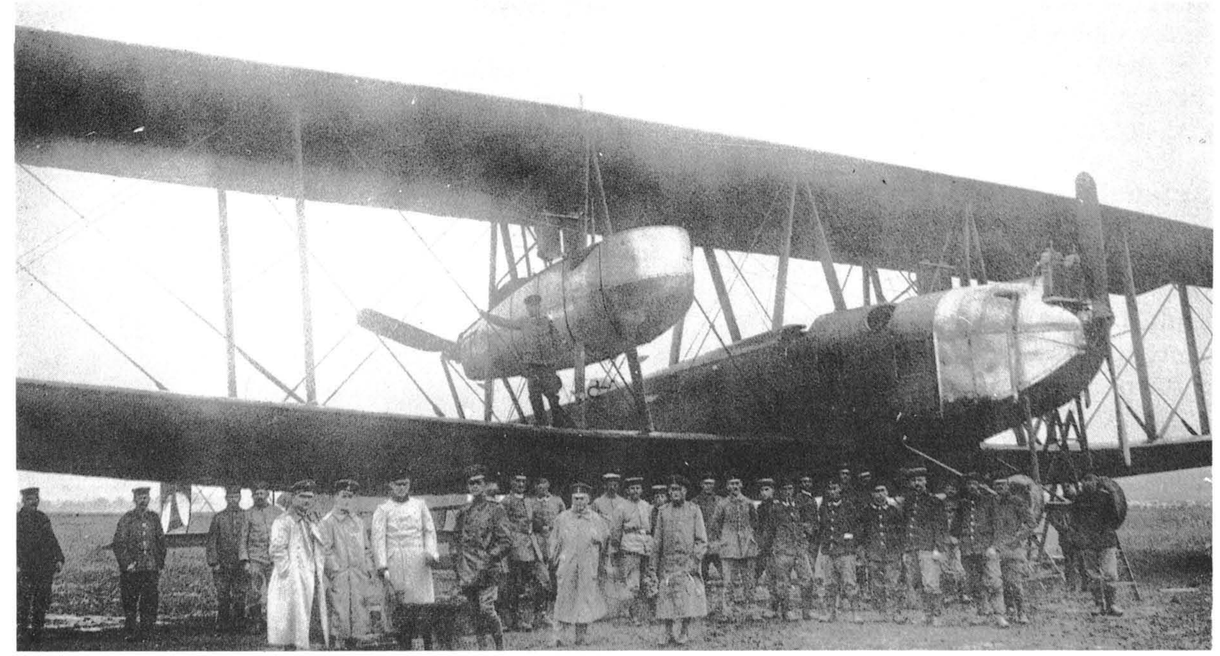
In addition to the bombing reports, the war diary contains fairly detailed reconnaissance information, including location of shore batteries, anti-aircraft guns and particularly ships. It is obvious that long-range, open-water reconnaissance was of prime interest to the Navy, and it was in this direction that the Naval Command guided the development of future naval R-planes. Possibly the poor results achieved in R-plane bombing attacks on moving vessels (while by no means conclusive) were responsible for the emphasis falling on the development of reconnaissance R-planes. This subject is discussed further in the chapter on the Staaken L seaplane.

Although the Navy Kommando L.R.I was disbanded, Rfa 500 continued to fly its R-planes and slowly increased its operational efficiency, surmounting many technical obstacles in the process. The former technical officer of Rfa 500, Richard Lühr, recalling the unreliability of the early Maybach



A bad landing made by the VGO.II at Paulsgnade.

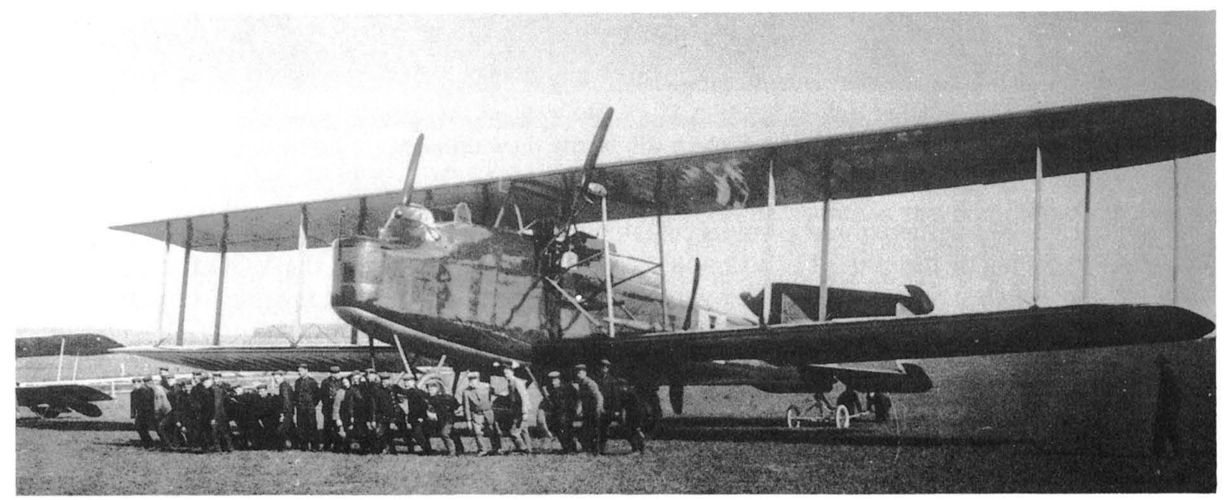
HS engines, said, "Never a flight without trouble." Once he was ordered to Friedrichshafen to take delivery of six new engines and not to return until they had passed their tests. In spite of his prodding the Maybach engineers to make changes and modifications, four of the engines failed their tests, and engines fully capable of front-line service were never delivered. Krupp, as commander of Rfa 501, also visited the Maybach works to supervise the testing of the HS engines. On the test stand they purred along beautifully at cruising speeds as would be encountered in airship service. Maybach engineers were aghast when Krupp gave these engines full throttle to simulate an R-plane take-off. All three engines on the test stand burned out within a few minutes. At the Front the HS engines were pampered to keep them serviceable for a reasonable duration. Lühr had special tracks built so that the aircraft could be pulled from the hangars on to the airfield by ground crews or oxen rigs, rather than use the engines for taxying the machines to take-off position. In spite of


The VGO.III, 8 September 1916 on delivery to Rfa 500.

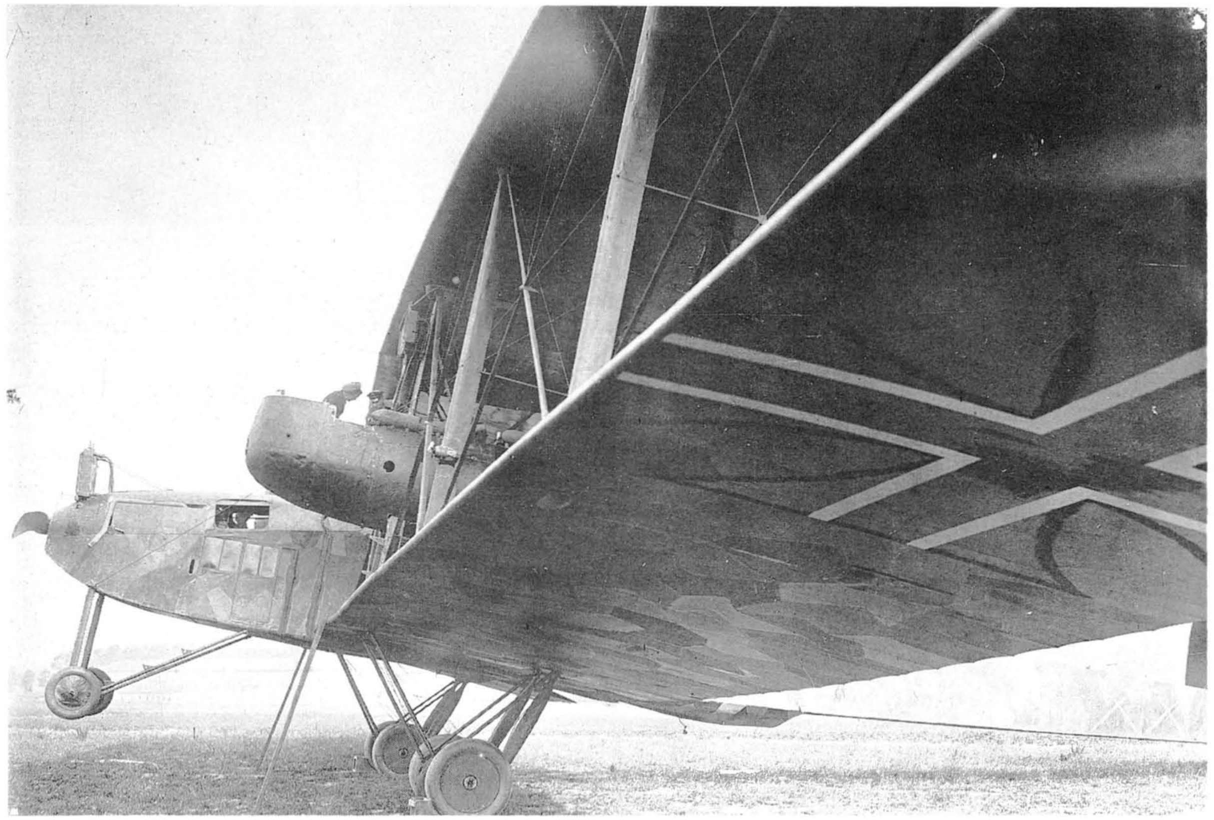
great efforts to make the HS engine a serviceable and reliable piece of equipment, it remained a failure.

New techniques had to be learned to perform seemingly simple tasks. For example, initially, it took three days to "swing the compass". This was done first with an empty aircraft, but the procedure had to be repeated again after the bombs had been loaded and once more after the crew, in full equipment, had climbed aboard. The sensitive airship compass was later replaced by a repeater compass located in the tail away from disturbing magnetic fields.

Then too, it seems that every flight had hazardous moments, often due only to minor mechanical failure. On the return from a bombing raid on Reval the engines of the VGO.II suddenly stopped. A quick check had shown the pumps to be dry, and while the floor of the wireless cabin was opened to inspect the main collector tank, the crew threw everything loose overboard to increase the glide in hopes of reaching Runö Island. It was found that a simple spring stop on the main petrol valve had


The DFW R.I 11/15, which saw service with Rfa 500 on the Eastern Front.

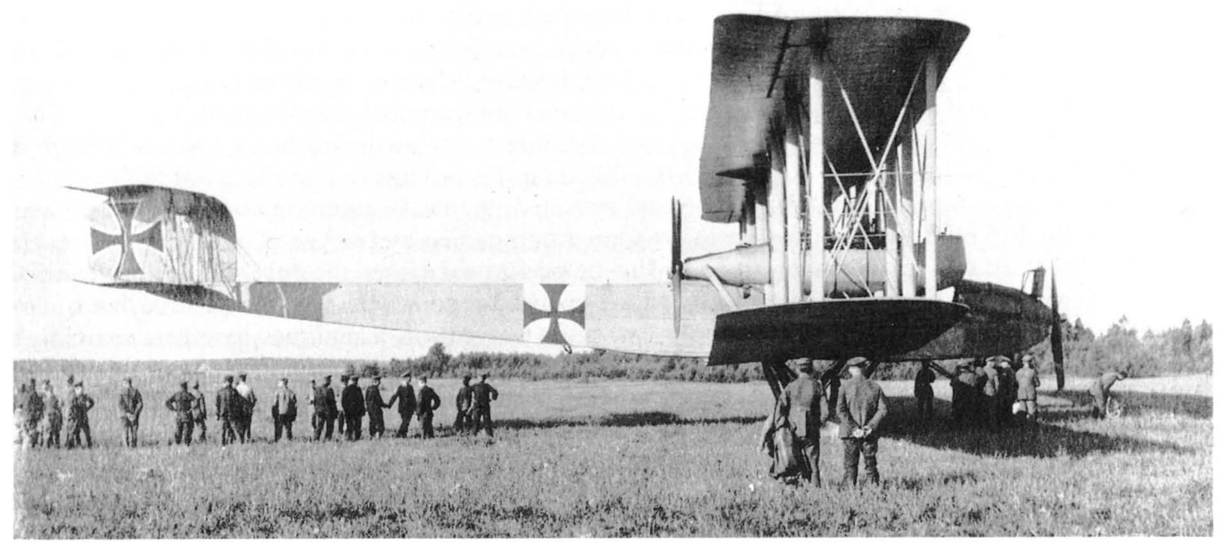
broken, allowing the vibration to slowly turn and seat the valve. At about 400 metres, with units of the Russian Fleet below, the engines fired up and the crew of the VGO.II escaped capture. Another time the wiring in the wireless cabin caught fire but was swiftly checked with a hand extinguisher. Continual close-calls such as these made the crews uneasy, and they did not relish flying these early, unreliable machines. With time they often became nervous and touchy. It has been said that on von Hallerstein's last flight in an R-plane he was so nervous that he fought the controls and was unable to control the machine by himself. The early R-planes were not easy to fly; on the contrary, it was hard work for one man. During periods of gusty summer weather pilots would often discard their flying-coats and helmets and fly missions wearing just their ordinary jackets open at the neck. "We sweated like bulls" was how Lühr aptly described it. Two complete turns of the steering-wheel were required to operate the ailerons (VGO.II), and flying was a continual struggle to counteract the movements of the aircraft in the air.



Staaken R.IV 12/15. The only R-plane to see action on both the Eastern and Western Fronts. Late style markings can be seen painted over the old Patée crosses which still faintly show through.

As experience was gathered and confidence gained, the two R-plane squadrons began to have an effect on the course of the war. For example, in one attack by Rfa 500, the VGO.II and VGO.III destroyed the switch-points at the railway yards at Rodenpois and delayed the departure of the First and Second Siberian Corps to Galicia for a crucial 18 hours. The importance of this and other attacks by Rfa 500 and 501 was not lost on the High Command, and certainly contributed to the launching of the large R-plane construction programme of 1916.

Information regarding the activities of Rfa 500 during 1917 is very incomplete. Its commander von Hallerstein was killed flying the experimental Dornier V.1 fighter at Friedrichshafen on 13 November 1916. The next known commander of Rfa 500 was Hauptmann Erich Schilling, who led the squadron on the Western Front until his fatal crash in the R.52 on 12 August 1918. Aircraft



Staaken R.IV 12/15, here seen at Alt-Auz early in its long operational career.

known to have been assigned to Rfa 500 on the Eastern Front were the VGO.II, VGO.III (crashed 24 January 1917), DFW R.I (crashed September 1917) and the Staaken R.IV. The DFW R.I flew only a single bombing mission on 13 June 1917, during which it dropped 680 kg. bombs on Schlok in retaliation for an earlier Russian raid. On 29 June 1917 the Staaken R.IV attacked the railroad station at Wolmar located on the Riga–St. Petersburg line with 1500 kg. bombs during a four-hour mission. Good results were observed. An excerpted combat report of its second mission on 9 July 1917 has been found and reads as follows:

> *Objective:* Bombing attack by R. 12/15 on the heavy coastal battery, munition dumps and troop encampments at Zerel (Oesel Island).
>
> *Crew:* Two officer pilots, one officer observer, one master mechanic, two gunners and one wireless operator.
>
> *Load:* Machine guns and ammunition 254 kg.
> 15 × 50 kg. and 60 × 12·5 kg. bombs 1500 kg.
> Other 2552 kg.
> Useful Load 4306 kg.
> Loaded weight 14,050 kg.
>
> *Duration:* Start, 00.07 hrs. Landing, 03.55 hrs.
> Time 3 hrs. 48 mins.
>
> *Route:* Alt–Auz–Talssen–Dondangen–Zerel and back (380 km.).
>
> *Highest Altitude:* 3200 m.
>
> *Action Report:* Take-off was made with flare illumination, landing in the early dawn without illumination. The flight was performed on instruments and compass. The Drexler gyro bank-indicator operated perfectly. During the flight, wind measurements were received on the wireless. Since the target lay on the coast which was delineated by the beach, the bomb-aiming telescope could be used with outstanding success.

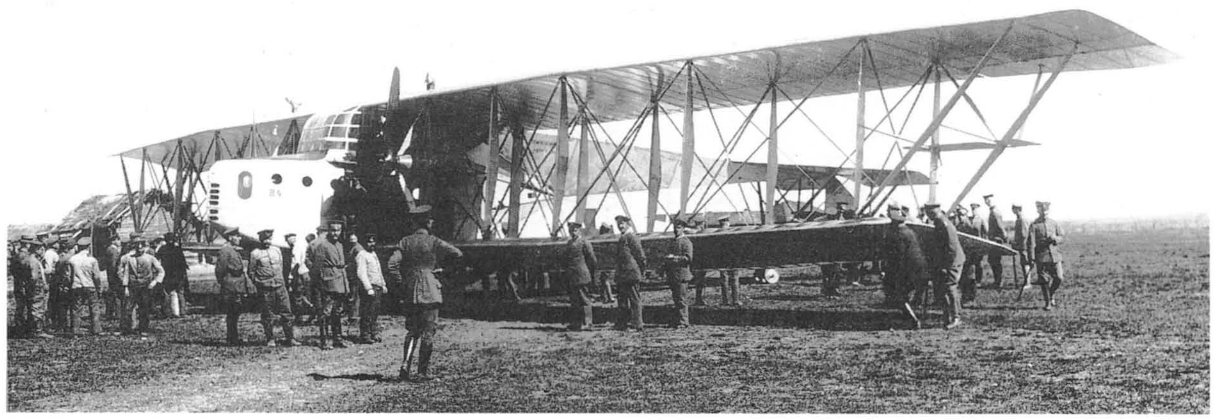
The R.12 reached the target at 02.00 hrs. and circled for 20 minutes. Most of the bombs appeared to hit the target. One large explosion forming a huge smoke cloud was observed. Russian anti-aircraft fire from both land and ships was inaccurate, no searchlights or enemy aircraft were seen. An Albatros C. VII accompanied the R.12. During the bombing it attacked the enemy anti-aircraft positions, thereby diverting attention from the R.12.

Rfa 500 probably left Alt-Auz in late 1917 and returned to Döberitz to re-equip and train with

the new Staaken R.VI machines. It was transferred to Custinne (France) in February 1918, and the activities of Rfa 500 on the Western Front are described in that section.

After the SSW R.1 had been shipped home, Krupp, in anticipation of new SSW R-planes arriving at the front, began to prepare for the extensive facilities that he knew would be required. He found a suitable airfield and barracks at Porubanok, a former military isolation hospital outside Vilna.[1] Large steel framework hangars were erected and facilities were put in readiness for the SSW R. 6, which arrived on 7 August 1916. Just prior to this date, on 3 August 1916, Rfa 501 was officially formed under the command of Oblt. Krupp and executed its first bombing mission on 3 September 1916, when the R.6 bombed Molodeczne in daytime accompanied by two escort machines. After the second daylight attack, further operations had to be performed under the cover of darkness due to the low operational altitude of the aircraft, which exposed it to severe Russian ground fire. This, in turn, required the development of entirely new night navigation techniques based on searchlight signals and coloured rockets fired at regular intervals.

Rfa 501 was commanded by Oblt. Krupp until November 1916, when Hptm. Richard von Bentivegni took over the command for the remainder of the war. During its service on the Eastern Front, Rfa 501 was attached to the German 10th Army; it was equipped exclusively with SSW R-planes, and its operational strength consisted of one to three R-planes and a number of escort aircraft.[2] The SSW bombers were active against Russian targets, but the exact number of missions



SSW R.IV 4/15, on the occasion of an inspection of Rfa 501 by General von Oven at Lyntupy.

flown is unknown. (For list of *known* raids which were flown by Rfa 501 on the Eastern Front see Appendix 4.)

The few existing combat reports of Rfa 501 and the correspondence between the squadrons and the manufacturers are filled with descriptions of technical and tactical problems that required solution before the R-plane could be considered ready for service on the Western Front. Taken one at a time, these difficulties may appear minor, but as a group they made a formidable list.

An excerpt from the combat report of the raid on Wileyka illustrates some of the difficulties encountered, in this instance, during a night mission. The report states that the engine noise of the R.5 was audible from a great distance and that the machine could be located in the dark; approaching head-on at 600 metres altitude, the glowing exhaust manifolds inside the engine-room were clearly visible, and as the R.5 flew overhead the fuselage was illuminated by the red-hot exhaust pipes that

[1] Now Vilnius in Lithuania.

[2] Delivery dates of the SSW R-planes to Rfa 501 were:

SSW R.6	7 August 1916
SSW R.5	4 September 1916
SSW R.7	February/March 1917
SSW R.4	April 1917

ran alongside. Sparks issuing from the exhaust enabled observers to follow the machine long after it had disappeared in the darkness. This, the report continues, explained why the Russian troops were able to spot the R.5 from a distance and subject it to accurate anti-aircraft fire at night. The report recommended sealing the engine-room windows and installing spark catchers.

Other problems exposed by the service tests of the SSW R-planes covered a broad spectrum. For example, the bank indicator was not sensitive enough, making it difficult to read under night-flying conditions; continual vibration caused light bulbs to fail; engine-room thermocouples read 15° C lower than those in the pilots' cabin, and the noise of the engines hampered communication between the pilots and mechanic, necessitating the field installation of an optical engine-telegraph.

Sometimes an oversight was responsible for a chain reaction of failures. Since the radiator of the R.5 had not been insulated, its vent pipes had frozen during a long winter flight. This prevented steam from escaping, and the pressure burst the radiator. The lack of water caused the engine cylinders to glow red-hot, melting the compression cocks and the metallic gaskets. The engine was stopped and the R.5 reached its airfield safely on two engines (7 January 1917). It was found expedient to replace the burnt-out engine by one originally intended for the R.6, but its gear-box flange was of different size. The report of this incident ended with a plea for the interchangeability of parts.

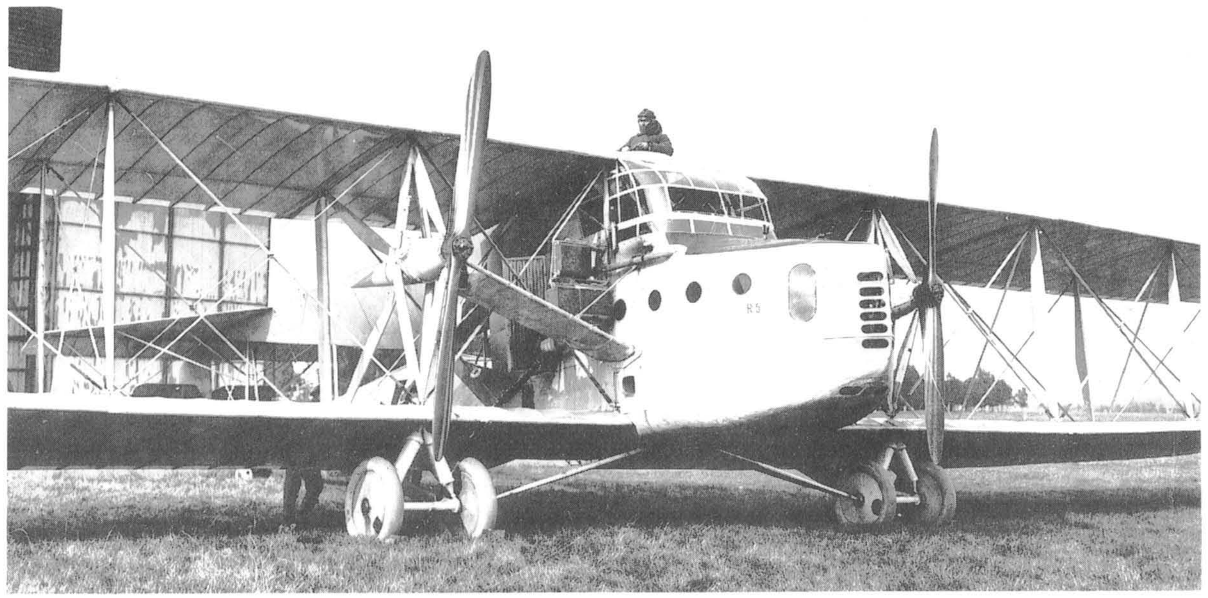
Problems such as the above were typical of those encountered and solved by the personnel of the R-plane squadrons. Although the aircraft were perhaps barely suited for combat service, their early deployment revealed shortcomings which would have otherwise remained unexposed. Without such front-line experience, the development of more reliable and powerful R-planes could not have been possible.

The following Rfa 501 combat report, translated and presented in the format of the original, describes a typical combat mission and the type of information which was reported to Rea for transmittal to the R-plane manufacturers.

SSW R.VII 7/15, in service with Rfa 501 against the Russians during 1917.

REPORT OF THE R.5 WAR FLIGHT ON 26 NOVEMBER 1916

Preparations: SSW R.6 had been standing-by for operational orders since its last flight on 15 November. The coupling defect which appeared on the last flight of the R.5 was repaired and the machine was ready for operational duty on 20 November, but it was not possible to perform a test flight until early morning of 26 November. Taking advantage for the first partially clear weather in a long while, both R-planes and the escort aircraft were prepared for a bombing mission. The weather and wind report which had been delivered earlier showed strong south-south-west winds and increasing cloud cover with rain to follow. At 10.30 hours a new weather report was requested which would take an hour to reach the squadron. Rather than lose the momentary opportunity to fly, the take-off was ordered for 11.00 hours.



The SSW R.V 5/15, which flew operationally with Rfa 501 at Vilna.

A rack for eleven 12·5 kg. P.u.W. bombs had been installed underneath the fuselage of the R.5, in order to drop a greater number of bombs on the troop encampment. The two supplementary bomb containers, each with a capacity of 5 P.u.W. bombs which had been installed at an earlier date behind the main bomb container, were removed. The weight of these supplementary bomb containers installed far behind the centre of gravity had made the R.5 very tail-heavy. For the intended raid the armament was increased to two machine-guns (one in the upper turret and one in the wireless position, shooting downwards) because only one escort aircraft was available.

Mission: to bomb the troop encampment at Iza (mission chosen at the discretion of Hptm. von Bentivegni, commander of Rfa 501).

Weather: Wind SSW, 16 to 20

R.5 Crew: Pilots: Lt. von Seydlitz-Gerstenberg
Offz. Stellv. Buth [1]
Commander: Hptm. von Bentivegni
Mechanic: Gefreiter Schröder

R.6 Crew: Pilots: Offz. Stellv. Hebart
Vizefeldwebel Arnold
Commander: Oblt. Borchers
Mechanic: Gefreiter Waldeck

[1] On 29 March 1918 Buth was awarded the Goldene Militär Verdienst Kreuz, the non-commissioned officer's Pour le Mérite. Buth was killed in the crash of the R.43 on 11 August 1918.

Flying Time: R.5: Take-off 11.15 hrs., Landing 14.00 hrs. ($2\frac{3}{4}$ hrs.)
R.6: Take-off 11.20 hrs., Landing 11.28 hrs. (8 mins.)

Route: R.4: Vilna–Wischniew Lake–Swir–Korkocyzyski–Vilna
R.6: Circuit of airfield

Attained Altitude:

	1000 *m.*	1500 *m.*	2000 *m.*	2150 *m.*
R.5	19 min.	32 min.	54 min.	69 min.
R.6	300 m./5 min.			

R.5 ACTION REPORT:

Start: The windows were left open during the take-off because it was necessary to start against the sun. At 400 metres the windows were closed and an increase of speed was noted. While flying through clouds the windows had to be reopened and remained so until landing. The window-frames greatly hindered the pilots' view of the terrain during the long time the R.5 flew at 200 metres. The Cellon canopy needs to be rebuilt as soon as the necessary material arrives.

Engines: Faultless.

Gearbox: After $1\frac{1}{4}$ hours the starboard engine clutch ran so hot that sparks shot out, in spite of having disengaged the leather-cone friction clutch five minutes after take-off.[1]

Engine Cooling: Faultless.

Controls: The rudder is too small. It was not possible to turn the machine into the wind with the rudder control alone; to do so required a combination of elevator and rudder control.

Instruments: The temperature indicator in the pilots' cabin did not function. The reason for failure has not yet been determined. With well-trained mechanics a single temperature indicator in the engine-room is deemed adequate.

Better communication between pilots and mechanic is desired. An optical engine telegraph is being constructed. The compass and inclinometer are satisfactory.

Bomb-release Mechanism: The electrical release mechanism of the main bomb container did not operate satisfactorily. Two bombs remained hanging and were released only after several attempts. The mechanical release of the P.u.W. bomb container was triggered by the mechanic on signal from the bomb-officer (commander) and operated perfectly. The choice of bombs must remain the prerogative of the commander, therefore the designers should attempt to install interchangeable bomb fittings. The bombing of troop encampments is without doubt more effective with fifty light, instead of ten heavy bombs.

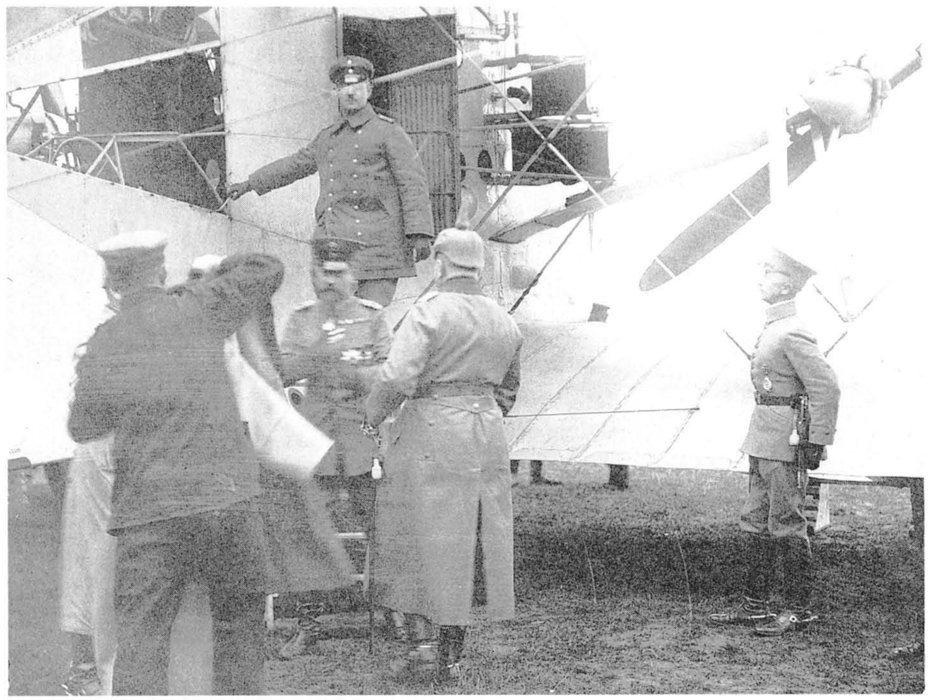
Armament: With a crew of four, as is now customary, the armament is hardly more than a useless load. The mechanic is too busy in the engine-room to man the machine-gun at the proper moment during an air battle. At this critical time the commander would be stationed in the nose and would not be able to reach his machine-gun in the dorsal turret. It is impractical to mount a machine-gun in the nose using the presently available MG-pivot because the pivot can not be properly secured to the fuselage. Even if an improved pivot were provided, a nose machine-gun would have a limited field of fire due to the construction of the fuselage. Finally, all of our pivots prevent training the machine-gun quickly in a strong slip-stream. This shortcoming will exist until the pivot is replaced by the proven gun-ring of a C-type aircraft.

Navigation: The aircraft headed for the Wischniew Lake at 100 metres altitude after making a wide circle around the airfield. Using the ground as reference, the drift was estimated at 10° and the speed at 150 km.h. At about 12.15 hours, the trenches along the Wischniew Lake were crossed at 2100 metres. The forward Russian trenches were clearly seen, but farther east a heavy cloud layer was sighted. After setting course for Iza, the

[1] The SSW clutch consisted of a conical leather-faced friction clutch and a centrifugal key clutch. This compound clutch was a constant source of trouble and not until it was modified and inspected after every flight was the reliability problem partially solved. (See SSW chapter for details.)

bomb-officer (commander) went to the nose to search for a troop encampment through the cloud-cover. Bombs were released, but unfortunately the bomb bursts could not be seen. During the bombing run the aircraft had to turn and the bomb-officer lost his orientation because the terrain was covered by clouds and the nose position was not provided with a compass. The aircraft headed north towards an opening in the cloud layer and flew on until a rain-cloud formation was encountered. Here we went down to 250 metres. The strong gusts almost prevented us from maintaining course. After a short time we spotted the railroad tracks (Dünaburg–Vilna) near Korkoczyski and flew along them. The three-quarter hour flight at 250 metres proved that the SSW R-plane can be flown in strong gusty weather.

Landing: Touch-down was smooth, but during the landing run the right front tyre burst.



Prince Leopold IV of Lippe leaving a SSW R-plane during a visit to Rfa 501 at Porubanok, summer 1916.

R.6 ACTION REPORT:

Start: The take-off followed the R.5 by 5 minutes, also with opened windows. At 300 metres a compression cock started to leak, forcing the R.6 to land. While replacing the cock, a new unfavourable weather report was received, and the commander decided to cancel the flight. In the future, mechanics will carry spare compression cocks on flights.

ESCORT AIRCRAFT—Albatross C.III 4077/15

Started 20 minutes later than the R.5 and remained in the immediate vicinity approximately 400–500 metres above us during the entire flight.

LESSONS LEARNED AND RECOMMENDATIONS

Technical: It was established after landing that the thrust ball bearing of the starboard clutch had seized and disintegrated. The causes for failure are twofold: the bearing is much too light; nor is it properly lubricated. The fact that this particular incident has occurred twice previously in the R.5 is enough evidence to prove that the strength of the thrust bearing is insufficient for this purpose.

Because the repair will require about three weeks, an attempt will be made to disengage the leather-cone friction clutch immediately after the engines have been started and to fly without using the thrust bearing.

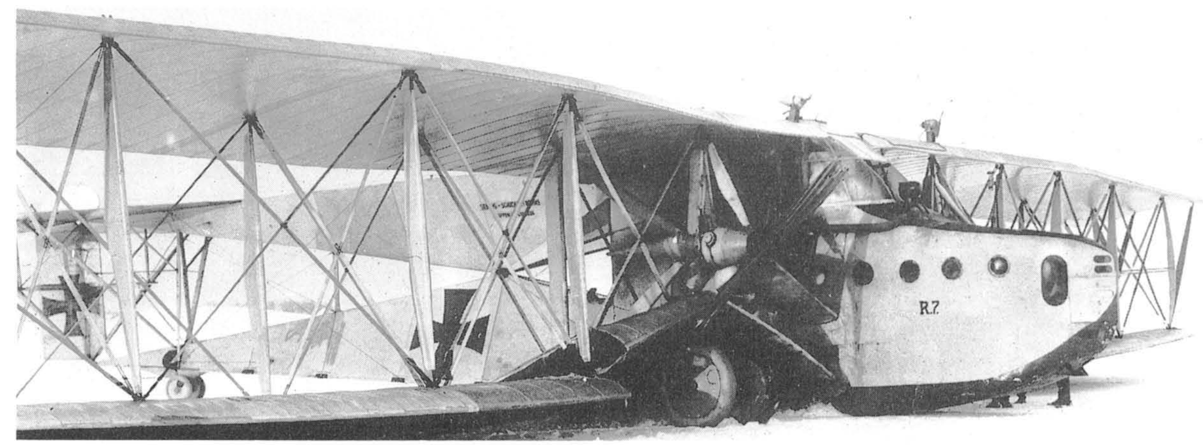
Instruments: The red and green lights used for signalling to the pilots from the upper commander's position (upper turret) have been very successful.

Meteorology: Under the local operational conditions the military weather reporting service becomes a decisive factor in the success of an R-plane squadron. The local weather changes so rapidly and to such a great degree that, in addition to front-line weather reporting stations, a suitable weather station must be established at the airfield. Only in this manner can wind and weather measurements be obtained promptly before the start of a mission.

Signed: *von Bentivegni*

These combat reports and incidents amply illustrate the variety of problems encountered by Rfa 500, Rfa 501 and Kommando L.R.I during their first months of operational service. There is no question that the officers, crew and engineers of the Rfas energetically solved many of the complex issues that confronted them and set the stage for R-plane operations on the Western Front. It is only necessary to compare these early combat reports with one written later in the war to see what progress had been made at all levels. The matter-of-fact attitude of the Rfa 501 combat report of 24/25 August 1918 (see page 42), is evidence that much had been accomplished in a mere twenty months.

Rfa 501 continued its activity on the Eastern Front until June or July 1917, at which time it was transferred to Berlin (Döberitz and Staaken) to train with the new Staaken R.VI bombers. Vilna became the base for an R-Schulabteilung (R-Training Section), which used SSW R-planes converted to trainers.



This photograph shows the SSW R.7 crashed at Vilna.

The SSW R.4 and R.7 were assigned to R-Schulabteilung Vilna and the SSW R.1, R.2 and R.3 were assigned to the Rea at Döberitz as trainers. Vilna remained a training base until 22 June 1918 at which time personnel were moved to the Rea Cologne which had been previously established to provide a support and training facility close to the Western Front. Two destroyed R-planes were found there by Allied troops at war's end.

R-PLANE RAIDS ON ENGLAND

During the time the R-plane squadrons were gathering operational experience on the Eastern Front the airship service had suffered staggering losses from which it never really recovered. The German Navy, on the one hand, continued to fight defeat under the energetic leadership of Korvettenkapitän Strasser, head of the Naval Airship Service, and his supporter Admiral Scheer; however, subsequent raids, even with improved airships flying at even-higher altitudes, proved to be ineffective. As a matter of record, London was bombed by naval airships only once after 1916, and this was a

case of pure luck; the airship was accidentally blown over London by high winds.[1] On the other hand, the Army, having G-type bombers and R-planes to fall back on, disbanded its Airship Service after the L.Z.107 executed the last Army raid on 16 February 1917. Incidentally, many of the airship crews were transferred to the R-plane squadrons, particularly the engine mechanics whose knowledge of the Maybach engine was found very useful.

In the autumn of 1916 Generalleutnant von Hoeppner, the Kommandierende General der Luftstreitkräfte (Kogenluft—Commanding General of the Air Forces) issued a memorandum stating that airship attacks on London had become hopeless and that the task of bombing the city would soon be assigned to the Fliegertruppe (Aviation Troops). The campaign against London was to rely on two new weapons: the G-type bombers of the Bombengeschwader (Bombing Squadrons) and the R-planes of the Rfas. An analysis of the total orders placed for R-planes shows that roughly one-half were ordered in 1916. The demise of the airship and the desire to continue large-scale attacks against London with heavy bomb loads were undoubtedly two of the factors behind the large R-plane construction programme of 1916.

Unfortunately documents concerning the exact nature of the military and strategical considerations which guided policy planners are not available. They would be of particular interest in the light of Germany's bomber policy in World War II.

Originally the London raids were to have begun in the spring of 1915; they were postponed until the spring of 1916, but plans again miscarried due to lack of proper equipment. By the time the Kogenluft memorandum was written (autumn 1916), the Gotha G.IV, an aircraft capable of bombing London, had been developed and the R-plane was considered to be "ready within a short time" to join the England squadrons. This last statement rings the bell of optimism so traditional in military planning documents. In fact, virtually a year was to pass before the R-plane made its appearance in English skies.

The London raids were considered by General Ludendorff (Chief of Staff of Field Marshal Hindenburg) to be primarily a strategic propaganda weapon. In his book *Kriegfrührung und Politik*, Ludendorff described the political situation in the spring of 1917, shortly before the beginning of the London raids:

> In the meantime, a compelling necessity had become manifest: to reinforce, through a large-scale increase in propaganda, the purely military conduct of the war and the unrestricted submarine campaign by an attack against the spirit of the enemy populace and its military forces. To assure final victory, its purpose was to shatter the unity of the enemy and dispel their belief in victory.

Major Frhr. von Bülow, the historian who analysed the London raids from the German point of view, wrote:

> The main purpose of the bombing attacks was the intimidation of the morale of the English people, the crippling of their will to fight and the preparation of a basis for peace. The secondary purpose of the raids was to disrupt the British war industry, disorganize the communication between coastal ports and London, attack supply dumps of coastal ports and hinder transport of war materials across the Channel. The target of the raids was confined principally to London because it was the heart of England, the operational headquarters of the Allies and the centre of its war industry.

The Kogenluft memorandum was accepted by the High Command and secret preparations for the great London raids were authorized to begin under the code name "Türkenkreuz" (Turk's Cross). The plans called for Bombengeschwader 3 to be operationally ready by February 1917, but delays in completing the required number of G-type bombers, difficulties in securing raw materials and failure of production aircraft to meet acceptance standards all combined to postpone the date of the first raid until the middle of May.

From 25 May to 22 August 1917 the Gotha bombers raided England in full daylight in groups of about twenty aircraft per raid. Day-bomber losses soon became intolerable. British defences had considerably stiffened since the first raids, and the slow speed and low attack altitude prevented the Gothas from evading ever-improving British air and ground defences. In order to continue the London raids, the German High Command was forced to change over to night attacks, the first of which took place on 3 September 1917. The shift to night missions coincided with the arrival of Rfa 501 in Belgium almost a year behind the Kogenluft schedule. In August 1917 Rfa 501 was transferred from Berlin to Belgium and stationed in the Ghent area. The main airfield of Rfa 501 was Scheldewindeke, which was equipped with a specially-constructed concrete apron. Other fields used generally in an emergency were St. Denis-Westrem, Gontrode and Ghistelles near Ostend.

[1] Known as the "Silent Raid" by airship L.45 on 19 October 1917.

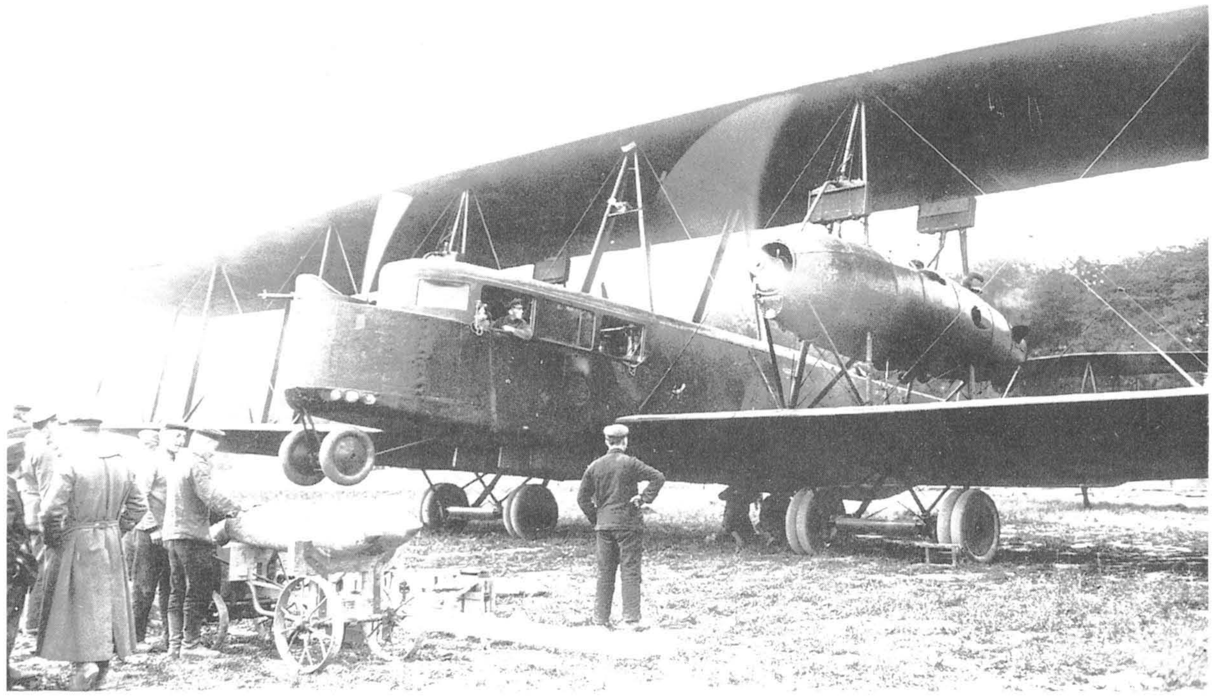
The decision by the High Command to attack England by night fitted the established pattern of R-plane operations. On the Eastern Front the crews had learned how to fly at night, and the problem of navigation and target location had been partially solved by an early form of radio triangulation. Also an extensive network of visual navigational aids consisting of flares, rockets and searchlights had been created to guide German aircraft through the dark skies. Navigational instruments especially useful for night flying had been developed: gyro-compass, gyro-bank indicators, inclinometers and wireless equipment. The German R-planes had come a long way since early 1915, and they entered the Western stage of operations on a fairly high level of technological development.

Ground personnel of Rfa 500 with 100 kg. and 300 kg. P.u.W. bombs.

A good deal has been written about the England raids flown by Bombengeschwader 3 and Rfa 501. As might be expected, the writings of German and British historians do not agree on every detail, but the description of the part played by the R-plane is essentially consistent throughout. Appendix 6 lists all the raids on England in which R-planes participated as extracted from German and British sources.

For purposes of co-ordination Rfa 501 was placed under the operational control of Bombengeschwader 3, and both squadrons received their orders directly from the German High Command (Oberste Heeresleitung). The aircraft assigned to Rfa 501 consisted solely of Staaken machines (R.IV, R.V and R.VI).

The German R-plane made its début over England on the night of 28/29 September 1917. Two R-planes and twenty-five Gothas started on the raid, but due to poor weather conditions only three Gothas and the two R-planes dropped their bombs on English soil. Poor visibility prevented the aircraft from reaching London, the intended target, and their bombs were released over the Thames estuary and over parts of Essex and Kent. Anti-aircraft gunners claimed three raiders, which tallied with the German reports of three aircraft missing, although their wreckage was not found On 29 September Generalleutnant von Hoeppner (Kogenluft) congratulated Rfa 501 for its first raid on the Western Front with the following message: "To the Commander of Rfa 501: I congratulate the participant crews on the occasion of the first successful attack with which the R-planes have begun their important assignment on the Western Front. I am confident that the R-plane will grow from flight to flight into an ever stronger offensive weapon."



The Staaken R.VI 39/16, taking on bombs prior to a raid.

On the next night (29/30 September 1917) three R-planes and seven Gothas sortied from their Belgian bases to attack London. Through the heavy overcast, three R-planes and four Gothas managed to find targets. Waterloo Station was struck by two heavy bombs, causing considerable destruction. One or more R-planes bombed Sheerness and its surroundings. A salvo of four bombs narrowly missed the Uplees Powder Works in Faversham. One Gotha was shot down in flames over Dover, but the three R-planes landed safely.

Rfa 501 did not attack London again for about nine weeks, due mainly to inclement weather; however, French targets may have been attacked by Rfa 501 in the interim. On the night of 1/2 October 1917 R.39 was aloft, possibly intending to accompany the eighteen Gothas on their way to bomb London. While in the air, R.39 transmitted wireless signals which were at once intercepted by a British radio monitor station. The German naval air station at le Bruges, in possession of British codes and ciphers, overheard the same British station warn the London defence system that an airship was in the area. R.39 returned to its base. This was not the only instance when British defences were confused by the presence of an R-plane. Before the British were familiar with R-planes, they were often mistaken for Gothas. Scarcely had operators of British listening equipment accustomed

themselves to detecting the engine sounds of the Gothas with a fair degree of accuracy when a new and much louder sound assailed their ears. The louder engines of the R-plane some 20 miles away were taken for those of a Gotha immediately overhead. Similarly, night interceptor pilots, who by now had developed special skills for locating Gothas in the dark, found it confusing and difficult to estimate the distance between their aircraft and the R-plane, due to the latter's greater wingspan. The guns of the defending aircraft were provided with sights for attacks on Gothas. When the pilot saw that the wingspan of the Gotha just fitted the sight, he knew that the enemy was within effective firing range. But the R-plane filled the sight at a much greater range, and British fire was therefore ineffective.

The next series of raids on London were planned as large, successive incendiary attacks, which the German High Command hoped would throw the populace of London into panic and confusion. The first incendiary raid, carried out solely by Gotha bombers, took place on 31 October 1917. The second raid occurred on 6 December, when sixteen Gothas bombed the London districts of Finsbury, Kensington and Whitechapel, causing considerable damage but few casualties. At the same time two R-planes armed with a total of 820 kg. incendiary and 1200 kg. high explosive bombs, had bombed Sheerness, Margate and Dover with negligible results. The third and last incendiary raid was executed by the R.12 and thirteen Gothas on 18 December 1917. It was a dim, moonlit night, and the British defences, for some reason, did not expect an attack. The raiders were helped by a blanket of snow which served to delineate the landmarks. Over London the R.12 released 400 kg. of incendiary bombs and two 300 kg. high explosive bombs, one of which damaged twenty-two houses in Lyall Street near Eaton Square. However, no fatalities were reported by the British. This marked the last of the incendiary attacks on England. The 4·5 kg. incendiary bomb was deemed a failure, and in consequence the raids had not, as the High Command had expected, thrown the citizens of London into a whirlwind of panic and terror. Nevertheless, the quest for an efficient incendiary bomb continued, and by the spring of 1918 German scientists had succeeded in developing an effective 1 kg. "Elektron" incendiary bomb.

According to Captain J. Morris, in his book *The German Air Raids on Great Britain 1914–1918*, it was on the night of 18 December 1917 that British Home Defence forces first became aware that giant aircraft were actually being used to bomb England. This information was probably supplied by Belgian spies or German prisoners. However, British and American Intelligence had known that at least one R-plane was stationed at St. Denis-Westrem (Rfa 501 airfield) as early as 25 September 1917, when a British reconnaissance aircraft had succeeded in bringing back a photograph of it standing on the airfield. But perhaps the British attitude at the time towards the R-plane, a new weapon on the Western Front, can best be illustrated by an American intelligence report dated 9 November 1917 which stated:

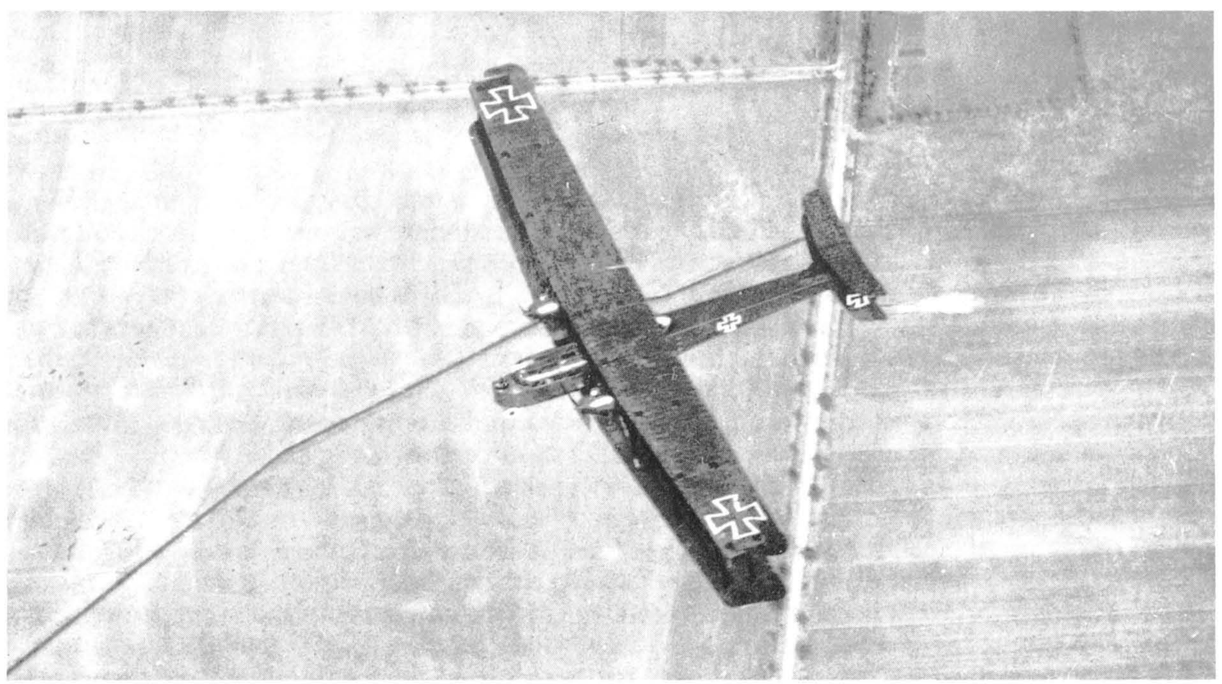
> Last week during a gale when the wind was blowing fully sixty miles an hour a telephone message was received in Dunkirk that a German aircraft was approaching. The British simply laughed at the idea that anyone could fly under such conditions and paid no attention to the telephone message. A short time later Dunkirk was bombed by this large German airplane, which was actually flying and dropping bombs on Dunkirk when the wind was blowing fully sixty miles an hour.

Three R-planes accompanied by a single Gotha (whose presence is not acknowledged in German records) set out to bomb coastal towns in Kent on 22/23 December 1917. One R-plane bombed the alternate target (Boulogne), but the R.12 and R.39 released a total of 2000 kg. bombs over the Thames estuary and reported that they had hit several ships. Even so, the combat record of the R.39 did not include this mission, possibly because it had not been a success. On the other hand, von Hoeppner issued an official communiqué congratulating the crew of the R.12 for its successful attack.

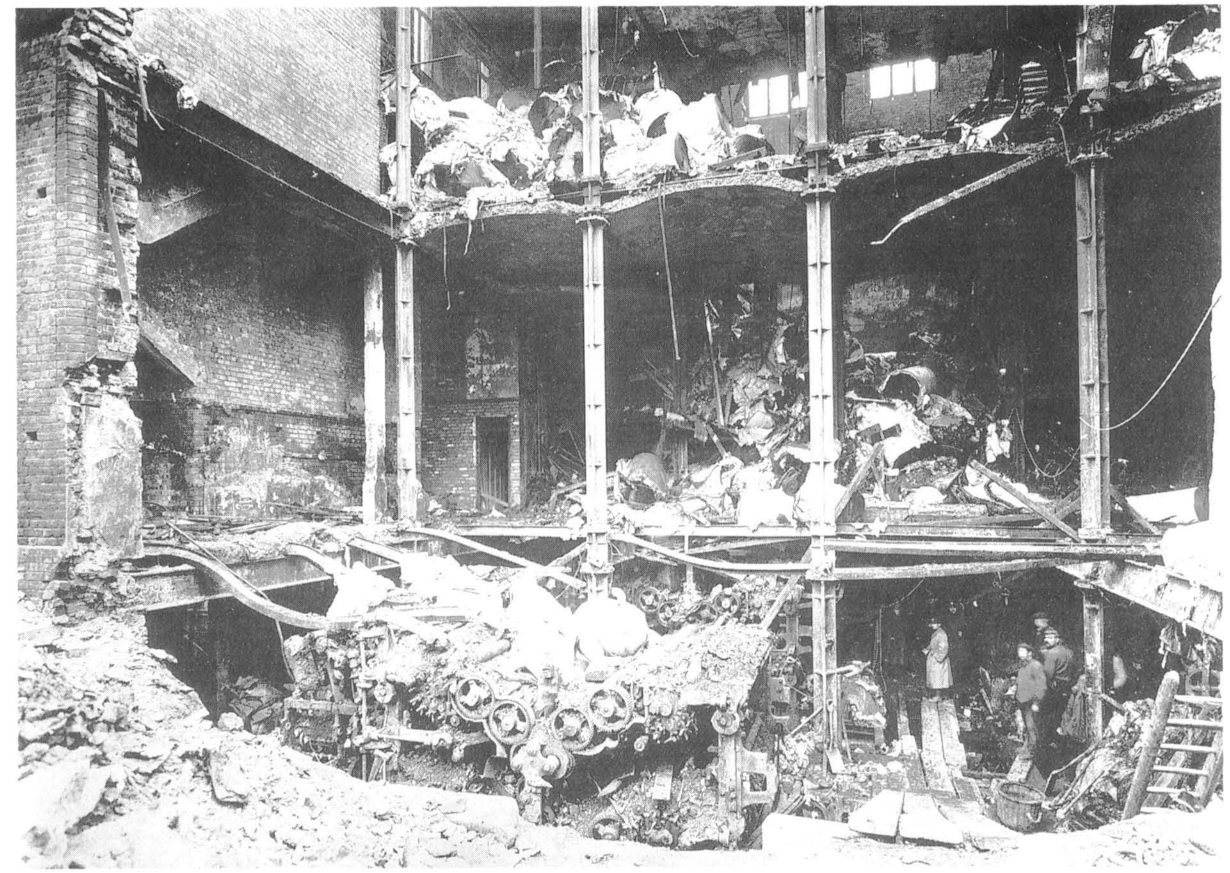
Three R-planes sortied against England on the night of 25 December 1917, but the alternative target, Boulogne, was attacked instead, due to a heavy fog blanket over England. As will be seen later, the commander of the flight could designate alternative targets by means of airborne wireless communication.

The R-plane was capable of putting up an effective defence because it provided a stable gun platform and it had a good field of fire. This was demonstrated by an R-plane which accompanied thirteen Gothas on the night of 28/29 January 1918. The R-plane was intercepted on its inward flight by two patrolling aircraft of the Home Defence squadrons. One machine closed to attack, but the R-plane commander managed to disengage by adroit manoeuvring. Soon after, the giant was again intercepted by a Bristol Fighter flown by 2nd Lieutenant Goodyear of No. 39 Squadron, Royal Flying Corps. In the sharp skirmish that followed, Lt. Goodyear's engine was put out of action and his observer wounded. The R-plane, having dealt with the defence aircraft, turned and dropped its bombs in central London; one of them, a 300 kg. bomb, crashed through a pavement grating outside Messrs. Odhams Printing Works (in Long Acre), publishers of *John Bull*. The bomb penetrated to the basement air-raid shelter and exploded with devastating effect, killing thirty-eight persons and injuring ninety. The lower walls and supporting pillars of the building collapsed, bringing three concrete stories down on the unfortunate victims. The conflagration that followed was observed by the R-plane's crew, who thought it was a hit near the Admiralty. After being turned from its homeward course twice by barrage fire and then being attacked by another British pilot, the R-plane flew safely home.

On the following night (29/30 January) good weather conditions prevailed and four giants, each carrying a total of 1000 kg. of high explosive, started on the first of several raids without the customary accompaniment of Gotha bombers. One R-plane was forced to return because of engine failure. Of the three remaining R-planes, one was diverted from London by the anti-aircraft barrage at Billericay and dropped its bombs on Rawneth, Thundersley, Rayleigh and into the sea off the Blackwater. This solitary raider caused no casualites and negligible damage. Captain A. Dennis of No. 37 Squadron, flying a B.E.12, attacked the second London-bound giant. In the fierce fight that followed, the B.E.12 received such a large number of hits that Captain Dennis had to retire, but not without causing the giant to veer off-course, dropping its bombs on Isleworth, Kew and Brentford as it went. A patrolling aircraft caught this giant again near Gravesend, but after firing 100 rounds the pilot was blinded by the flash of his own tracers and the quarry escaped. The third giant was intercepted near North Benfleet and vigorously attacked by four fighters, forcing the raider to prematurely drop its bombs on Wanstead. The giant flew very low and according to the British was on the verge of landing when the



A Staaken R.VI in flight.



Odhams Printing Works, Long Acre, hit by a 300 kg. bomb on the night of 28/29 January 1918. This was the worst single incident caused by air raids during World War I.

fighters drew off. This was a most successful night for the British Home Defence; although it did not succeed in shooting down any giants, it prevented them from reaching the centre of London and caused them to drop their bomb load off target with minor results.

The overcast night of 16/17 February 1918 saw the giants over England again. The Germans had chosen this night to drop their first 1000 kg. bomb, the largest bomb to be dropped on English soil in the war. The dubious honour of carrying the bomb went to R.39. Of the five raiders, R.39 and R.12 penetrated the London defences and the 1000 kg. bomb hit the North Pavilion of the Royal Hospital, Chelsea. Five people perished in the explosion, which caused destruction over an exceptionally wide area. The R.12 dropped two 300 kg. bombs on Woolwich, killing seven people and injuring two. The eight 50 kg. bombs that fell at Beckenham exploded harmlessly in a park. The R.25 claimed that it had bombed Dover with good effect, but from the British side the bombs were seen to explode harmlessly near St. Margaret's Bay east of Dover. The R.33 was forced to drop its bombs prematurely into the sea at Deal because of engine failure. With three of its four engines dead and flying 200 metres above the Channel, it barely reached the Belgian coast and landed safely. The exploits of the fifth raider are not known.

It was during this raid that the R.12 commanded by Oblt. von Seydlitz-Gerstenberg flew into the balloon apron which was stretched between the Woolwich Works and the West India Docks. Here is an excerpt from his combat report:

> The aircraft was first pulled to starboard, then port and finally side-slipped out of control to the port side. The first pilot, Lt. Götte, immediately throttled-down all engines, then opened up the throttles on only one side, whereby the aircraft regained equilibrium once again after having fallen 300 metres. The impact of the balloon apron was so severe that the

Section of the damaged façade. Royal Hospital, Chelsea. This was the result of the first 1000 kg. bomb to be dropped on Great Britain, 16 February 1918.

> starboard mechanic fell against the glowing exhaust stacks, which severely burned his hands, and the port aileron control cables sprang from their roller guides. The aircraft itself remained intact with the exception of minor damage to the leading edge of the starboard wing, propeller and mid-fuselage section.

The next night, 17/18 February, as if to atone for its previous night's failure, the R.25 made what the British considered the most successful attempt at bombing a particular objective in England during World War I. General weather conditions were hazy, but the visibility to the ground was good. The R.25 was over the Nore at about 22.00 hours, and approached London from the south-east. German records indicate that several Gothas were over England that night, not to drop bombs, but to act as a decoy for the solitary raider. It was a successful ruse, and ground defences and aircraft were led astray by reports of enemy machines approaching. In the confusion that followed, Home Defence interceptors were fired upon by their own anti-aircraft guns. The R.25 flew unmolested towards London, first dropping two trial bombs on the illuminated[1] southern part of the city, followed by a slow, intermittent release of ten bombs individually aimed at house-blocks in the Lee, Lewisham, Peckham and Southwark districts. The attack was climaxed by unleashing a tight salvo of 8 × 50 kg. bombs over the centre of London. Although an explosion and conflagration were observed by the commander of the R.25, he did not record whether he had recognized the objective beforehand. At any rate, the bombs fell near St. Pancras Station, damaging the Grand Midland Hotel, stores and offices in the surrounding area. Twenty people were killed and twenty-two injured.

[1] It is not clear whether the city was not blacked-out or illuminated by moonlight.

The R.25 described the defences over London proper as being weak, but those on the outskirts as very strong. Anti-aircraft fire was only effective after the R.25 was picked-up by searchlight; several hits were scored and the port rear propeller was damaged so that the engine had to be stopped.

Only one of the sixty-nine patrolling interceptors, a Sopwith Camel, managed to bring the R.25 in its sights; however, the pilot of the Camel was forced to break-off the engagement after he was blinded by his own tracer fire. The combat report of the R.25 ended with this significant statement:

> An attack by a single R-plane is sufficient to alert the entire British defence system and to cause the expenditure of vast quantities of ammunition. It is seemingly from nervousness that not only anti-aircraft guns in the vicinity of the aircraft but also some 30 km. distant were being fired blindly into the air. For example, on our homeward flight a great barrage was being laid-down over Sheerness while we were still south of Rochester.

Implicit in this statement is the principle of strategic containment of forces which the German High Command disregarded in their later evaluation of the R-plane as a strategic weapon.

The raid on 7/8 March 1918 marked the only time that the full strength of Rfa 501 was able to sortie against England. All six bombers approached in heavy clouds and strong winds, but were assisted by the light of the aurora borealis. One bomber was forced to turn back before crossing the English coast. Of the remainder, three reached London, one was observed over Luton and the fifth did not get past the anti-aircraft barrage at Billericay. The British reported seventeen bombs dropped on the following districts: St. John's Wood, Whetstone, Hampstead and Battersea, causing slight damage. The second 1000 kg. bomb to fall on England hit No. 67 Warrington Crescent, Maida Vale, demolishing twenty-three houses, killing twelve persons and injuring twenty-three. The raiders were caught several times by searchlight beams, and accurate anti-aircraft fire compelled them to change course from time to time. Forty-two Home Defence aircraft attempted interception, but none succeeded on this overcast night. Two Sopwith Camels collided in the dark, and their pilots, Capt. H. C. Stroud of No. 61 Squadron and Capt. A. B. Kynoch of No. 37 Squadron, were killed. Two R-planes, one of them the R.27, the other unknown but possibly R.36, crash-landed in Belgium.

Hptm. Arthur Schoeller, commander of the ill-fated R.27, described his participation in the raid, and his record is a valuable account of a typical day of an R-plane squadron on the Western Front. A bombing raid, then as now, required an immense amount of preparation. The squadron commander submitted daily status reports to the High Command, which contained a summary of the weather conditions and meteorological forecasts obtained from German stations at Blankenberghe and at various locations along the North Sea (for Rfa 501). The status report gave the number of R-planes ready for action. If conditions were favourable the commander would request permission to commence preparations for an attack.

On 7 March 1918 Rfa 501 was transferred from Gontrode to the newly-completed airfield at Scheldewindeke. Without being given time to settle in its new quarters, the commander ordered Rfa 501 to attack London that night. But let Hptm. Schoeller continue the story:

> Our six aircraft are rolled out on to the T-shaped concrete apron and parked in preparation for the take-off. We have been ordered to ready the machines for a night attack, and for this task the R-plane crew, which consists of two pilots, one observer/navigator, two mechanics, one fuel attendant, one wireless operator and one machine-gunner, is assisted by a ground crew of some forty men. The highest-ranking officer on board is the R-plane commander, who also acts as the first pilot or navigator. Under the commander's supervision every crew member bends to his assigned task. The wireless operator tests his equipment for readiness to receive and send messages; the fuel attendant sees that the ten 245 litre fuel tanks are properly filled and topped, the mechanics, who are situated between the two engines in the nacelles, tune the engines and prepare them for the start and the machine-gunner arms the four machine-guns. A good deal of time elapses before the R.27 is ready to accept its bomb load. The bombs, which may range from 50 to 1000 kg. and are released electrically, are hung in long, rectangular bomb bays underneath the fuselage floor between the wings and enclosed with folding doors.

On top of these preparations there is just enough time for a frugal supper and dissemination of orders. A last comprehensive study of charts and orientation material with my observer, Oberleutnant Günther Kamps and the second pilot Unteroffizier Bühler, then out to the armed R.27, whose idling engines sing a song of subdued power. At exactly 20.00 hours Hptm. von Bentivegni fires the starting flare and the first of the R-planes strains forward with an ear-deafening roar. We are next to taxi to the take-off strip and ten minutes after the first aircraft, with full throttle R.27 heads into the clear dark night.

Slowly the heavily-loaded machine rolls over the ground; finally it is airborne, and after a wide curve around the aerodrome we head in a direction along the pin-marked course on our maps. Inside the fuselage the pale glow of dimmed lights outlines the chart-table, the wireless equipment and the instrument panel, on which the compass and other navigation instruments are mounted to help guide us through the darkness. Before long, we spot the signal cannon at Ostend, which fires star shells into the night to assist us on our way.

We approach the coast; the night is so dark that the coastline below is but a mere suggestion. Under us is a black abyss, no waves are seen, no lights of surface vessels flicker as we head for the Thames estuary at Margate. On our right, in the distant north, is our only light, the weak pulsating glow of the aurora borealis. Ahead of us a black nothingness—are we on the correct course? We have neither a weather report from the high seas [*note:* presumably from German submarines] nor wind measurements to go by.

The R.27 started in clear sky. Now thin but continually thickening cloud shreds streak past. We climb over the cloud cover, through which holes now and then appear, but beneath nothing is sighted, although from our elapsed time we must now be over England. The flight continues without a sighting; did we possibly miss the English coast? Suddenly, a breath of relief. Directly ahead the searchlights illuminate the sky in their hunt for us, their bright beams making glowing circles in the thin overcast, but do not spot us. Now we are certainly over England, but where? Because all surface lights are blacked out, it appears as if we are soaring over a dead land. But the enemy has heard us, therefore we are free to request wireless bearings. The operator sends a pre-arranged signal which is received by two specially-alerted stations in Belgium. In a few minutes we receive a message giving our location at the time we flashed our signal. We are south-east of London.

Accompanied by searchlights which seem to guide our way, we fly towards the Thames, whose dock installations are our target. Can we recognize the docks through the low overcast, against the darkened countryside which lies beneath? Directly ahead, the landing lights of an English airfield flare up as the enemy prepares to intercept us. The machine-gunners arm their guns and fire at the searchlights below. On this particularly bright-lit aerodrome Oblt. Kamps releases four bombs, and the detonations are clearly seen. This is in return for attacks on our aerodromes. All at once, through a hole in the cloud cover the grey band of the Thames momentarily appears. We continue on course, and during the next sighting Oblt. Kamps, who is standing next to the bomb-release mechanism in the open bow of the machine, presses the bomb-release keys. Not far ahead we can see a portion of the balloon barrage which surrounds London's eastern and southern periphery.

We turn for home along the Thames, whose banks are dotted with anti-aircraft batteries that soon have us under fire. As we approach the coast the overcast becomes thinner and thinner; before long the searchlights catch us and the bursts of the anti-aircraft move dangerously closer. A shell splinter tears through our upper wing without causing any damage. The flaming shells come so close we can almost touch them. Beneath us, we spot the exhaust flames of a pursuing night fighter, but it does not threaten us. In this manner, we reach the open sea at Margate and steer for Ostend, where well-known signals will guide us home. After a seemingly endless flight, they come into view and we feel secure again.

But fate wills differently. As we come into sight of the coast, the steady rhythm of our engines begins to falter, until suddenly all four propellers stop. Some split-second thinking: the fault can only be in the fuel system. The last two fuel tanks had just been connected. What had happened? The fuel lines had frozen due to water-contaminated gasoline. To

thaw them out is impossible, and so a forced landing becomes a certainty. The question is, will we reach the coast, or are we to sink in the sea? In any case, life-jackets are strapped on. Fortunately the great gliding qualities of our R-plane enable us, in spite of stopped engines, to reach the coast behind our own front which we recognize from the firing of artillery.

By means of flares we search the darkened landscape on which we must land, but only trenches and hollows are discernible. At best, the landing will end in a crash, but it means annihilation if the heavy, ponderous machine should collide with an obstacle on the ground. Therefore, by pulling sharply on the controls I stall the aircraft letting it fall almost vertically against the ground. With a mighty impact it hits in front of a wide ditch. The right landing gear collapses and the right lower wing shatters, but no crew member is injured.

At 04.30 hours we find ourselves close to a command bunker of an infantry brigade, and like shipwrecked sailors we are hospitably received. We notify our squadron, which makes arrangements to save valuable instruments and the engines from the wrecked R.27, which later was destroyed by enemy shell-fire. A few days later, the whole crew is on the way to the Schütte-Lanz Works at Zeesen to pick up a replacement for the R.27 in the form of the R.28 and deliver it to the front.

The full strength of the London squadrons was mustered for a final all-out attack on London during the night of 19/20 May 1918. The German force was composed of thirty-eight Gothas, three R-planes, and two C-types armed with a total of 14,550 kg. high explosives, including one 1000 kg. bomb.

Part of the damage in Warrington Crescent caused by the 1000 kg. bomb dropped by the R.39 during the raid of 7/8 March 1918.

Thirty-four aircraft reached the English coast, and of these eighteen Gothas and one R-plane succeeded in piercing the London defence system. Criss-crossing London from all directions, the raiders strewed seventy-two bombs on the city, while other aircraft dropped thirty-six and forty-nine bombs on Essex and Kent respectively. The total casualty list as reported by the British was quite high: forty-nine persons killed and 177 injured, but the British authorities considered the effect of the raid light in relation to the size of the attacking force. Two R-planes discharged their bombs, including

Staaken R.VI 30/16 prepared for flight. Before installation of supercharger. Oberleutnant Meyer is the pilot.

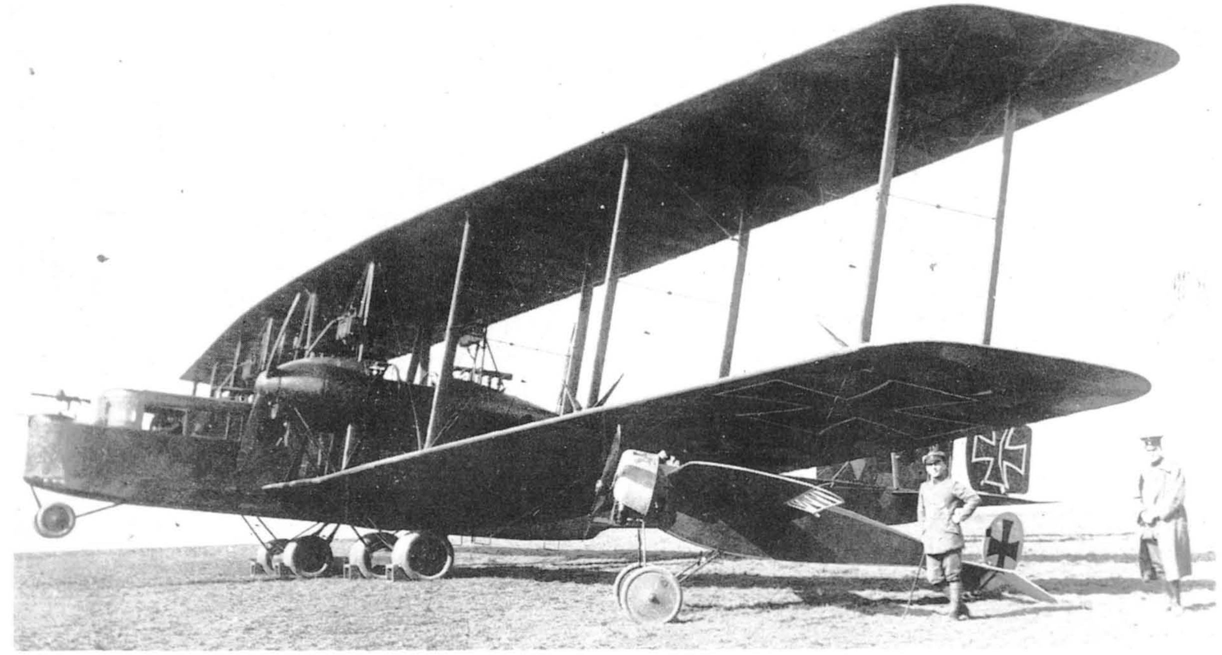
the third and last 1000 kg. bomb to fall on England during the war, but the damage reported was slight.[1] Six Gothas were lost in this last great raid; however, the three R-planes returned safely to their base.

This marked the last of the raids on Great Britain, for the aircraft were urgently required elsewhere. Germany had begun the final and most desperate offensive campaign of the war, and every available weapon in her arsenal was placed in support of her ground forces in France. The possibility of bombing England again at some later date still existed, and indeed, in early August 1918, four Bombengeschwader (including Bombengeschwader 3) were poised to attack London and Paris with the newly-perfected "Elektron" incendiary bomb weighing but 1 kg. The High Command, however, cancelled the raids just one half-hour prior to take-off time. Later in August the question of bombing London and Paris was definitely settled. The war had irretrievably turned in favour of the Allies, and the so-called "propaganda" raids on England and France would no longer have served their purpose. In the face of imminent defeat, the German High Command forbade bombing attacks on London and Paris for military-political reasons.

So ended the R-plane attacks on England. Altogether eleven raids by a total of twenty-eight R-planes were flown against England by the crews of Rfa 501 in a period of about eight months. Rfa 501 dropped 25,970 kg. of high explosive bombs (including three 1000 kg. bombs) and 1220 kg. of incendiary bombs on England, for a total of 27,190 kg. all told.

[1] Actually R-plane crews preferred to carry three 300 kg. bombs which were known to be far more effective than a single 1000 kg. bomb.

It is a remarkable fact that Rfa 501 suffered no personnel or aircraft losses by enemy action during its raids on England. Two R-planes crash-landed in Belgium for other reasons. In sharp contrast stand the losses of Bombengeschwader 3, which totalled sixty-one aircraft; twenty-four were lost as a result of enemy action and thirty-seven were lost due to landing mishaps, fire and crashes. The number of men lost by Bombengeschwader 3 has not been determined, although a reasonably close estimate based on the total lost during the war (137 men) would be between 80 and 100 men.[1]



Staaken R.VI(Av) of Rfa 500.

What conclusions did the Germans reach regarding the R-plane's accomplishments in the light of the England raids? According to the German historian von Bülow, the reinforcement of Bombengeschwader 3 by the giants of Rfa 501 did not come up to German expectations. Von Bülow's first criticism was that the bomb load carried by an R-plane was small compared to the aircraft's total weight. But this criticism could just as well have been levelled against the Gotha as a bomb-carrier, for analysis shows that both aircraft carried about 8 per cent of their total weight in bombs. For short-range attacks the Gotha was more efficient in terms of bomb load carried, but for the England raids the bomb load was reduced to carry extra fuel. And it should be remembered that the R-plane's total weight included additional engines, which made the R-plane much safer, more difficult to shoot down and more reliable than the twin-engined Gotha.

Although R-planes dropped 27,190 kg. of bombs on England, von Bülow continued, this total must be equated against the cost, time and effort required to construct and equip an R-plane, not to mention the vast number of rear echelon personnel and supplies necessary to keep an R-plane in the air.[2] Even then, the R-plane was seldom ready for deployment. Of the six R-planes available to Rfa 501, only in one instance did all six machines take part in a raid. Had it been possible for all six R-planes, each carrying a 600–1000 kg. bomb load, to start on every mission and have at least four R-planes hit the target, then, von Bülow felt, the R-plane could have achieved great success. Throughout the war, the R-plane was never quite ready for continued front-line service; it was simply too complex, too cumbersome and too dependent on specially-constructed airfields and service facilities.

[1] For a statistical comparison of both squadrons see Appendix 5.

[2] The strength of Rfa 501 was about 750 men and six aircraft, which meant that 125 men were required to keep one R-plane in operational service.

In this criticism von Bülow was essentially correct. The fact was that there simply were not enough R-planes constructed to perform a greater number of missions. On the other hand, von Bülow, in criticizing the R-plane's poor service availability, did not, it seems, take into account the raids flown by Rfa 501 against France during periods when it was not bombing England, nor instances when R-planes had taken-off but were forced back by weather. The list below, though incomplete, does show that Rfa 501 was active against continental targets on off-days during the England campaign.[1] Although the full number of these "secondary" missions is not known, there can be no question that the R-plane possessed better service availability than von Bülow thought.

One factor not considered by von Bülow was the R-plane's ability to complete a mission once having started. According to available records, twenty-eight out of a total thirty R-planes that took-off for England managed to drop their bombs on England, or in other words 93·4 per cent of the machines completed their mission as compared to the Gotha bomber's 76·4 per cent. Obviously the greater reliability provided by four or more engines gave the Staaken R-planes a distinct advantage over the G-type bombers not only in their ability to complete an attack but also to return home safely.

Finally, the R-plane was a strong opponent and difficult to shoot down, as demonstrated by the fact that none were lost to enemy action during the England raids. The R-plane was provided with four to seven machine-guns with overlapping fields of fire, so that several guns could be trained on one attacker. The British pilots were fooled by the R-plane's size, and consequently opened fire before coming within range. In addition, the ·303 calibre machine-gun bullet was too small to deal effectively with the giants unless the range was very close.[2] Perhaps this was the reason why the Germans were planning to install one or more 2 cm. Becker cannon on late model aircraft. This would have made the R-plane an even tougher nut to crack.

One gets the impression from reading von Bülow's account of the England raids that the Germans placed the greater emphasis on the tactical success of the bombers (i.e. the destruction of targets) rather than giving first consideration to what was supposed to be the primary objective of the England raids: strategic propaganda to destroy the morale of the English people and their will to fight. The extensive countermeasures taken by the British Government showed that it was exceedingly concerned over the effect the bombing raids might have on the British people; and indeed the situation on the Home Front almost reached crisis proportions, although the British people did not crack. In this propaganda objective, then, the bombing raids failed, but the Germans seem to have almost completely neglected to take into account the large amount of troops and quantity of material drained-off from the Western Front by the British to combat the bomber menace. It is interesting to note that out of the last nine raids on England, five were flown exclusively by Rfa 501. While Bombengeschwader 3 was either grounded or attacking targets in France, the R-plane was able to maintain pressure on England and tie down a vast defensive system out of all proportion to the relatively small effort expended by the Germans. The raid of the R.25 on 17/18 February 1918 was graphic evidence of how a single R-plane could evoke a massive response by the British.

It was a strategic mistake by the Germans not to continue their night attacks by R-planes on England and other large cities. This would have been far more profitable for the Germans than squandering the long-range capability of the R-plane on short-range tactical targets, as was later the case on the Western Front.

[1] Known sorties by Rfa 501 during time of the England raids: R.39 was in the air on 1 October 1917, one R-plane attacked Dunkirk in the first week of November 1917, three R-planes were forced back by fog from a raid on England on 25 December 1917 and bombed Boulogne instead; Rfa 501 was slated to bomb Paris on 11/12 March 1918 with Bombengeschwader 1, 2, 5 and 7, but could not participate due to ground fog covering the airfield; R.39 bombed Boulogne and St. Omer on 1 April and 21 April 1918 respectively, possibly accompanied by other R-planes, and on 9/10 May 1918 four R-planes from Rfa 501 bombed Calais–Dunkirk. For additional raids see Appendix 7.

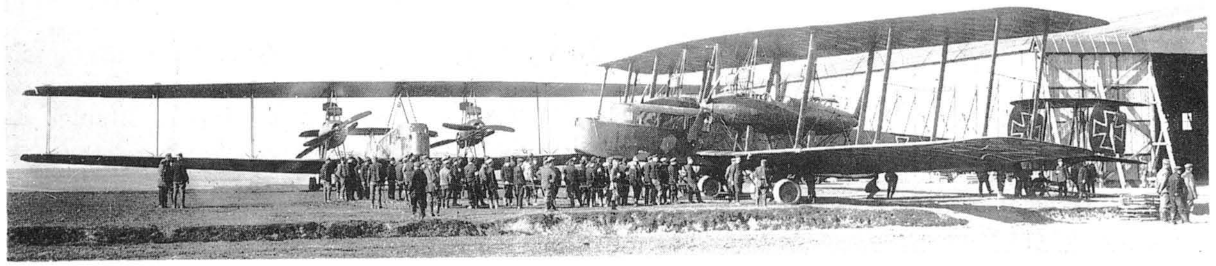
[2] To shoot down the R.43, Capt. Yuille closed to within 25 yards before opening fire (see Staaken R.XIV chapter).

WESTERN FRONT OPERATIONS

Very little has been written about the service record of R-plane squadrons operating against targets in France. This lack of documentation may well be attributed to the fact that the R-plane was used primarily as a tactical rather than as a strategical weapon on the Western Front. Although its missions here were even more hazardous, the tactical employment of the R-plane was less glamorous and had less impact on the Allied war effort. The G-type bombers, being more effective for tactical purposes, received the biggest share of the glory. It was a time when the urgency of the German military situation forced the R-plane into a role for which it was ill-suited. R-plane targets in France were generally tactical objectives, such as rail junctions, supply dumps, assembly areas and other installations close to the front-lines. In isolated cases long-range attacks against Paris, le Havre, Deauville, Rouen and several other cities were performed, but these raids were the exception rather than the rule. So in the summer of 1918 German military planners chose to disregard the differences between short-range tactical and long-range strategic bombers, and gambled everything in support of their last desperate offensive. It is felt that the original objectives of the R-plane squadrons should have remained targets deep within enemy territory, beyond the range of any other aircraft. Against targets such as London and Paris, just a few R-planes would have successfully continued to divert badly-needed interceptor squadrons, anti-aircraft batteries and troops from the front.

In attacking tactical targets the advantage of surprise was lost, and in addition the R-plane was exposed to established defences of rear sectors. Furthermore, the R-plane was not nearly as flexible as the twin-engined G-types. On the night of 21/22 July 1918 several crews of Bombengeschwader 4, equipped with Friedrichshafen bombers, managed to complete six missions. An R-plane could only hope to complete one mission per night, regardless of the distance involved, because of the time required to prepare the machine for flight. Consequently, it would have made sense to exploit the

Hptm. Schilling with officers of Rfa 500 in front of Staaken R.VI(Av) 33/16.



Staaken R.VI(Albs) 36/16, and R.VI(Av) 33/16 of Rfa 500 being prepared for flight.

The same two aircraft lined up. The balanced ailerons and central fin of R.36, the nearest machine shows this to be a later model than its companion.

great range of the R-plane and leave short, repetitive raids to aircraft designed for this purpose. In the final offensive gamble the R-plane became a victim of expediency.

After its last London raid Rfa 501 continued to operate from Scheldewindeke against French targets until the end of the war. Rfa 500 was transferred from Döberitz to Custinne (in France) during February 1918, specifically (according to British intelligence reports) to bomb Paris.[1] French sources list a total of twenty-eight raids against Paris and its outskirts by German bombers in 1918, but R-planes are mentioned as participating in only one raid. On the night of 1/2 June 1918 eleven bombers, including two R-planes from Rfa 500, attacked Paris. One machine, the R.37, was fired at by four French anti-aircraft batteries, forcing it to crash-land near Betz. The R.37 was set afire by its crew of three officers and seven men before being captured.[2] This was the first R-plane confirmed

[1] Rfa 500 was reported by British intelligence as being stationed at Custinne (February–May 1918), Morville in Belgium (May 1918), Dinant area, probably Morville (June–August 1918) and Morville (August–September 1918).

[2] A British report stated the crew of the R.37 escaped.

lost as a result of enemy action since the operational début of the giants in 1915. The R.37 was not destroyed as completely as its crew might have desired, and parts of the aircraft were scrutinized by Allied experts. Because it was the first machine of its kind to be examined close-up, it became the subject of much attention by the British and French Press.

A classic example of the tactical misuse of the R-plane took place on 10/11 August 1918, when the R.43 of Rfa 501 was shot down while attacking Doullens. (For details see Staaken R.XIV chapter.) The target was located only 25 km. behind the front lines, yet on the same night G-type bombers attacked Etaples, a city situated deeper in enemy territory than Doullens. This was the first of two victories that Allied aircraft had in dealing with the giant bomber. Two factors contributed to the loss of the R.43. One, it was attacked by specially-trained pilots of a British night fighter squadron and, two, the R.43, by attacking an objective close to the front lines, had exposed itself to the concentrated defences of the rear sectors.

Staaken R.XIV 43/17 in flight.

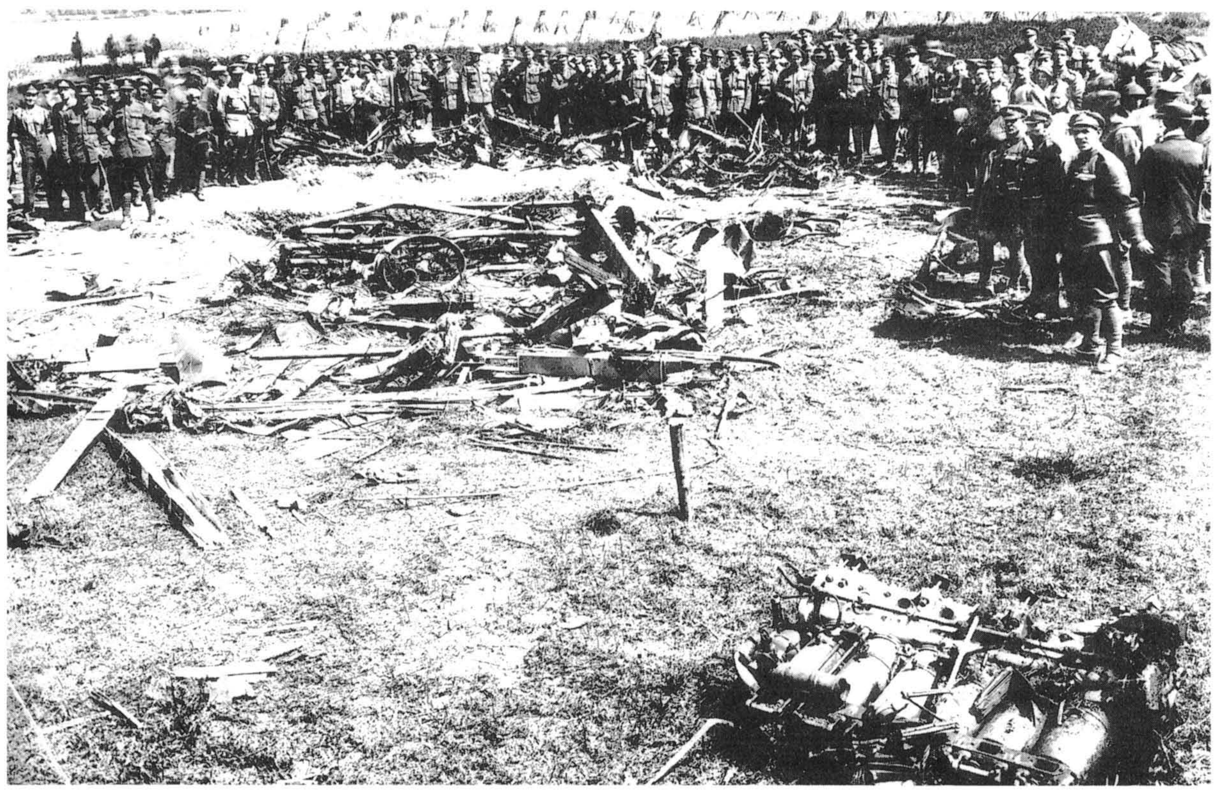
Similarly, on the next night (11/12 August) the R.52 was ordered to bomb the small, blacked-out town of Beauvais, only some 50 km. from the front lines. It was on this raid that Hptm. Erich Schilling, commanding officer of Rfa 500, and four other members of the crew were killed. The R.52 was a new machine, heavier than previous types, and the pilots were unaccustomed to the changed position of the cockpit. (See Staaken R.VI chapter.) It was a pitch-black night over Villers la Tour when the R.52 side-slipped, caught itself and side-slipped again. The right wing hit the ground, and fuel from burst tanks spilled over the hot engines and ignited. This was the only instance when an operational R-plane crashed as a result of uncontrollable flight manoeuvres.

An analysis of the distance between the targets (see Appendix 7) and existing front-lines shows that, with the exception of Rouen, le Havre and Deauville, all targets were located within 100 km. of the front lines, and in most cases even less.

Although these bombing raids were generally short-range missions during which the navigator could rely greatly on visual navigational fixes such as landmarks, starshells, searchlights, etc., the R-plane wireless communication techniques had not been neglected. The Rfa 501 combat report for

24/25 August 1918 not only demonstrates the degree of sophistication achieved in the realm of airborne wireless communications but also indicates by its matter-of-fact attitude the amount of progress which had been made, both operationally and technically, within a time span of two years.

As a word of explanation it should be noted that the command of the aircraft rested not with the first pilot but with an officer who, in addition to his all-important navigation duties, kept abreast of the weather situation by wireless and chose new targets or landing fields as dictated by weather changes. There can be no question that a high degree of skill and alertness was required for the formidable task of finding the target and bringing the aircraft safely home at night. All R-planes were equipped with a small, two-cylinder petrol-driven engine which drove a 1000-watt generator.



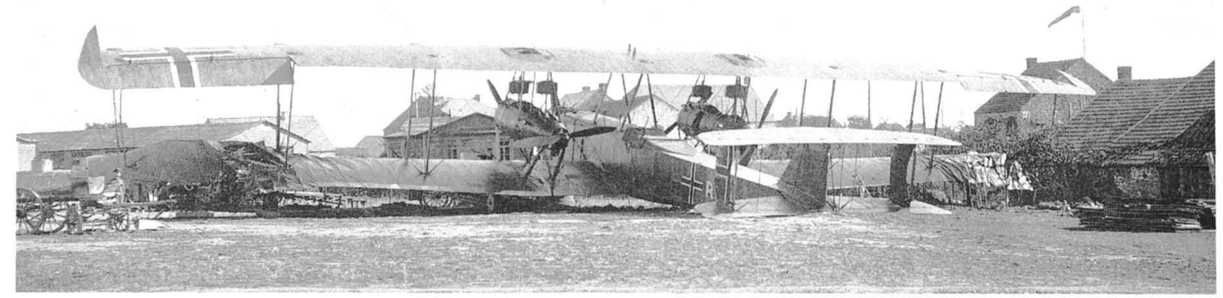
Remains of the Staaken R.XIV 43/17, shot down by Capt. Yuille R.F.C.

This in turn supplied power to a receiver/transmitter which operated on a wavelength of 300–1000 metres and had a nominal range of 600 km. The equipment, built either by Telefunken Gesellschaft or Dr. Erich F. Huth, G.m.b.H., was used to establish the position of the aircraft by a triangulation method,[1] to keep abreast of sudden changes in the weather and to pass on commands to other R-planes *en route* to the target.

As an example of a typical mission using wireless command procedures, Hptm. von Bentivegni had this to say in an official combat report:

> Report of attack on targets B and C on night of 24/25 August 1918: During a spell of favourable weather, an attack on targets chosen by the Armee Oberkommando 4 (Army Command 4) was ordered by me as follows: Target: A; Alternative targets: B (Gravelines) and C; Fuel for 6½ hours; Bomb load; 1200 kg. each; Aircraft: R.12, R.13, R.25, R.39.
>
> I am aboard R.39. Permission was given to take-off any time after 17.30 hours. Approach to target A (a French coastal city) over the sea. This approach was mandatory to avoid unnecessary exposure from anti-aircraft fire on the moonlit night. It was especially disturbing that we were not allowed to fly directly across the German night pursuit sector, because the route along the Dutch frontier required longer flying time and there was a danger of crossing the Dutch border. During the approach flight a weather report warned that fog would have to be reckoned with after 03.00 hours. After receiving this wireless message, I calculated that it was impossible for all aircraft to land before 03.00 hours. Consequently, I directed a wireless order to the squadron to attack auxiliary target B (Gravelines). This order was received by all aircraft. Target B was attacked by three aircraft, which dropped 3600 kg. of explosive bombs with unquestionably good results. The fourth aircraft attacked target C due to engine trouble. All aircraft returned safely.

[1] When the navigator wanted a position fix he would transmit a signal which would be picked up by two specially-alerted ground stations. Both stations would take a bearing on the R-plane's signals, determine its position and transmit this information back to the R-plane, providing the navigator with a reasonably accurate fix. Not all navigation was done by wireless; the Germans had also established an extensive network of pre-arranged coloured searchlights, periodic star shells and other light signals for all their night-flying aircraft, from single-seaters to R-planes.



Staaken R.XIV 45/17. Photograph shows the condition of the machine after a night landing at Morville, Belgium. Notice the position of the cockpit behind the wings, unique to the R.45 among Staaken R-planes.

From the standpoint of the crew, an R-plane raid was an exciting adventure as indicated by Wilhelm Pfaff's recollections of a raid on le Havre by Rfa 500:

> Prior to take-off, as was customary, only the commander and the two pilots were given the name of the target. The rest of the crew did not find out until the aircraft had returned. At dusk the R.45 took-off from Morville. It became dark and soon we were over the front, which was illuminated by a fierce gun battle raging below on both sides. Over the front we were not fired at by anti-aircraft guns; this aroused our suspicions and we kept a sharp look-out for enemy night fighters. But nothing happened. As we penetrated deep into enemy territory, we could still see behind us the shell bursts and fires around St. Quentin. Suddenly in the vicinity of Amiens searchlights and brisk anti-aircraft fire appeared; then it was again quiet for a long time. The commander opened the door to my engine-room in the nose of the aircraft and gave the sign to fuse the bombs. I laid myself on my stomach, opened a bomb-bay hatch and fused one bomb after the other. While I was working on the last bombs, I noticed that several had been released. I remained lying in the inner fuselage to observe if all bombs had been dropped. In the meantime, the first bombs must have hit the ground, for in an instant, as though someone had pressed a button, we were flooded by the glare of searchlights. It seemed to me as if we were bathed in flames. Noticing that the bombs were all gone, I closed the bomb-bay doors, and as I got up the first pilot made a sign for me to hold on. At this moment, when our lives depended on split-second timing, the actions of the two pilots were not co-ordinated. The first pilot wanted to put the aircraft into a dive, and the other pilot wanted to climb. At his signal I gave the first pilot a hand and the R.45 went into a dive. While this was happening the searchlights lost us and the anti-aircraft batteries had to cease fire. All this lasted only a few seconds, but it cannot be

described by words or in writing. It must be experienced. It was estimated that forty to sixty searchlights had captured us in their beams, in addition to anti-aircraft shells exploding on all sides of us. But the daring dive gave us greater speed, which enabled us to escape this hell. From my long experience I could see that all my comrades had remained calm and collected throughout the action. I went forward to my post in the nose engine-room. With my ear against the wooden handle of a screwdriver I listened to one cylinder after the other, and gave the valves a squirt with the oil-can. The engine sounded fine. From my window I could see that we were over the sea and guessed that the commander had chosen the shortest route back to Morville. Over the front we again came into contact with searchlights and anti-aircraft fire, but after having dropped our bombs we were able to fly at a higher altitude, where the French defences could do us no harm. Furthermore, at this altitude we did not fear interception by enemy night fighters. As I was checking my fuel consumption, the wireless operator nervously squeezed past in his haste to reach the commander with an urgent wireless message which said, "Do not land at Morville, enemy pilots overhead, airfield not illuminated." The commander went to his chart table and calculated the fuel requirements to reach an alternate airfield. Then he gave the wireless operator the message: "Must land, no fuel, on landing approach make signals with flashlights." We cruised several times around the airfield and the nose engine was stopped. The flashlights were easy to spot, but because men were running around with flashlights we had no indication of what was going on down below. The first and second landing attempts failed. For the third landing attempt the commander gave me a flare pistol with ammunition. Quickly I went to the window, opened it and shot one flare after the other in front of the aircraft to illuminate the terrain ahead for the pilots. As the pilots saw the edge of the forest, they brought the R.45 down for a landing.

It was during this landing run that the R.45 was damaged. (See Staaken R.XIV chapter for details.)

After Hptm. Schilling's death in August 1918 Oblt. Max Borchers, formerly with Rfa 501, was named to command Rfa 500. Towards the end of the war the number of available R-planes dwindled and the service strength of Rfa 500 was reduced from six to finally one R-plane. Consequently, on 23 October 1918 Rfa 500 was merged into Rfa 501, and von Bentivegni came to Morville to lead the combined squadrons. Several unserviceable R-planes were left behind in the Ghent area.

OPERATIONAL LOSSES

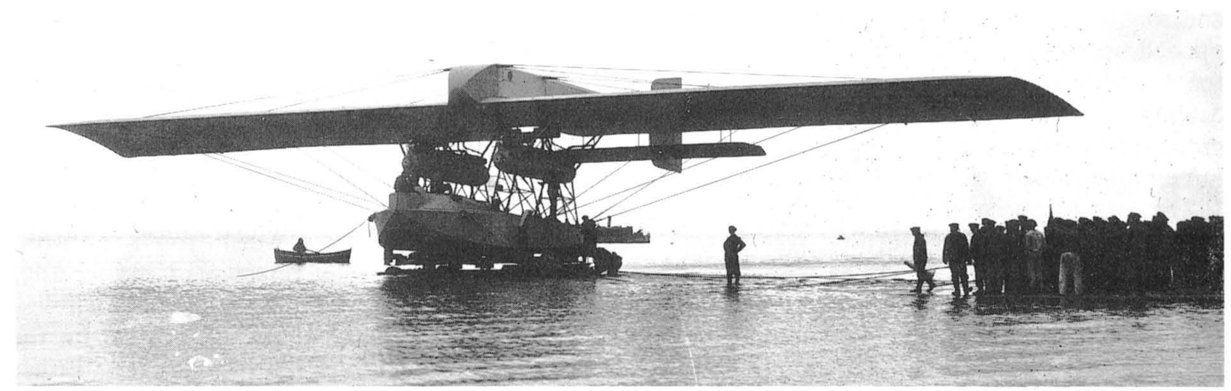
The R-plane squadrons suffered the greatest proportion of their losses on the Western Front, where they were flown under conditions quite different from those on the Eastern Front. Allied defences were strong, and every effort was being made to combat bombing attacks. Heavy anti-aircraft batteries had been established in specific defence zones, night interceptor squadrons were operational, and night-bombing of German bomber airfields was an accepted routine. In spite of energetic Allied counter-measures, it is surprising that only three R-planes have been definitely confirmed as victims of enemy action. French anti-aircraft fire forced the R.37 to crash-land; the R.31 and R.43 both fell to night-flying Sopwith Camels of 151 Squadron R.A.F. This total of three R-planes tallies with von Bülow's count, although he does not cite particulars. One other giant, the R.34, crashed after combat, but it is not clear whether the cause was enemy action or some internal failure.

In a sense, the R-plane was its own worst enemy if one considers that the majority of the operational losses occurred while landing. The landing losses fall into two categories; those resulting from some emergency situation and those during which an attempt was made to land under marginal weather conditions. Most of these accidents happened in times of reduced visibility, at night or in foggy weather, which, of course, severely restricted the pilot's range of action. Another handicap was that night flying, a relatively new skill, required techniques that were not fully developed until many years after the war. The R-plane's low landing speed was a saving grace which lessened impact forces and

usually enabled aircrews to escape the fire which generally followed a crash. Casualty lists for the R-plane squadrons have not been published, but the officer casualties for operational R-planes seem reasonably low.

Allied intelligence bulletins contain a scattering of prisoners' (never identified but not necessarily R-plane crews) and Belgian civilians' statements that the R-plane was too accident-prone. These statements were probably true, for there were many minor landing mishaps (for instance, landing-gear collapse) that were not serious but which kept the machine out of action until repairs could be made.

In Belgium the R-plane squadrons operated at a disadvantage with respect to the weather. The West European weather front generally moves in from the north-west, travelling across Great Britain before reaching the Continent. The German meteorology service possessed no sure means by which to make long-range weather predictions. In some cases submarines would transmit weather reports from the high seas, but this source of information could not be depended on. During the England phase of operations the bombers generally flew into an advancing weather front, which gave them ample time to turn back and land safely or attack an alternative objective if the weather looked ominous. In France the situation, with exception of targets on the Channel coast, was reversed. After taking-off from Belgium the R-planes for the most part flew in the opposite direction from the oncoming weather front, and unless a timely wireless warning was received, the R-planes were liable to return and find their airfield closed-in by fog. This was exactly what happened on 9/10 May 1918, when four R-planes, although warned, found themselves separated from their airfield by a thick fog blanket after returning from a mission. The combat report prepared by surviving officers of Rfa 501 told in detail what had occurred:



Dornier Rs.III at Norderney. The only seagoing R-plane to be flown operationally during the war.

On 9 May 1918 four Staaken R.VI machines (R.26, R.29, R.32 and R.39) took-off at 22.05 hours from Scheldewindeke to bomb Dover, but were ordered to attack the alternative targets Calais–Dunkirk instead. The prevailing north-west wind was considered favourable because the aircraft, flying into the wind, would be able to anticipate oncoming bad weather. Orders had been given to return to the airfield immediately if a fog warning was received by wireless. R.32 and R.39 had successfully dropped their bombs on Dunkirk when a wireless message was received warning the aircraft that the amount of ground and low-altitude fog over the airfield was increasing. R.32 and R.39 headed back at once, but the two other aircraft flew on for they were just a short distance from their target, Calais.

R.32 and R.39 arrived over their airfield shortly before 01.00 hours, when the airfield signalled by wireless: "Cloud height 100 metres, Brussels clear visibility." For reasons not documented, both aircraft decided to risk the landing at Scheldewindeke in spite of the wireless warning. The elapsed time between the wireless message and landing attempt was about 25 minutes, during which time a fog bank had descended on the airfield. The R.32 made several landing approaches, but each time it lost its direction in the fog. The searchlight beacons could be seen from the top of the fog layer as washed-out circles of light. It was these beacons that established the position of the airfield. However, as it

was not possible to see them from within the fog bank, the landing approach was made on instruments, intuition and luck until the searchlight beacons appeared again out of the fog. R.32 was flying towards these when it hit a row of trees 700 metres short of the field and crashed. The explosion of an unreleased bomb and remaining fuel completely destroyed the R.32 and most of its crew. The R.39, as it emerged from the fog, flew directly between the two beacons at the edge of the airfield and barely rolled to a safe stop at the end of the runway, within inches of a ditch.

A member of Rfa 501, Paul Büttner, vividly recalled the anxious moments waiting for the aircraft to land on that fateful night. He could hear only the recurring noise of engines and first learned of the R.32's end when a badly-injured crew member stumbled across the airfield with the news that most of its crew had perished in the crash. The crew of the R.39 owed their lives to its skilled pilot, Lt.Frhr. von Lenz, whose experience and precise knowledge of the beacons' position brought the machine down safely.

At 01.30 hours the R.26 and R.29 arrived over the airfield and a wireless message was received by them which said: "Landing impossible, clouds 100 metres high, Ghistelles clear for landing." A further message, received at 01.50 hours said: "Land at Ghistelles, otherwise use parachute." In spite of these orders, the R.26 and R.29 chose to land under the presumption that below 100 metres, at least, there were no clouds and visibility was good. The R.26 flew into the ground and burned; all, except one mechanic, were killed. R.29 made an approach along the edge of the fog bank, using its landing lights to avoid flying into the ground. As it was impossible to locate the airfield under the fog layer, the R.29 climbed over it using its gyro-compass. Having picked up the beacons and under the impression that the cloud bank was still at 100 metres, R.29 attempted a glide approach. In the clouds the aircraft turned 60–80° to starboard in spite of the pilots' efforts to the contrary and lost its course. Suddenly, at the bottom of the cloud layer, the pilots saw tree tops. They immediately opened up the engines to pull the aircraft into a climb, but it was too late. The landing gear caught the tree tops, pulling the fuselage down into the trees. Although the fuel tanks burst, the R.29 did not catch fire, thanks to the quick-witted pilot who had at once shut-off the ignition of the engines and motor-dynamo. The remains of the completely demolished R.26 were not found until the next day, but enough remained of the R.29 to be dismantled and salvaged.

The catastrophe was carefully studied by the Germans, who came to several conclusions. It was shown that the weather warning system was not infallible. Instead of the word "fog", the word "cloud" was used several times, and the R-plane commanders naturally interpreted the weather situation incorrectly. It has not been explained why the weather service did not transmit more wireless reports in view of the rapidly-changing fog height. Finally, the R-plane crews did not act on the orders received by wireless; they did not fly to Ghistelles nor, if short of fuel, did they bail out. Either case would probably have cost less lives than the abortive landing attempts. The striking decision of the crews to land their aircraft can only be attributed to their faith in the ability of the pilots to bring them safely down. But in retrospect, it seemed poor judgement not to fly to Ghistelles or bail out, and as a result the R-planes suffered their greatest single loss in the war.

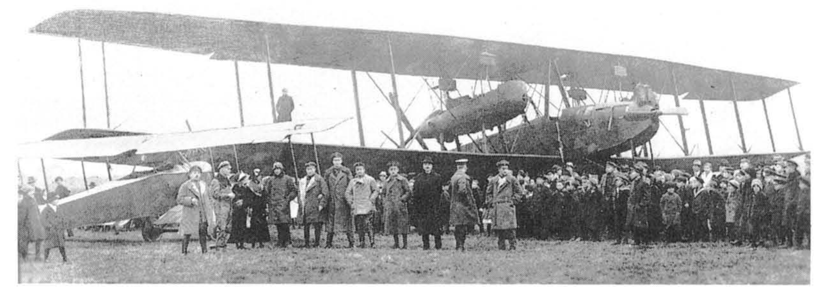
A typical example of an emergency situation was the one which involved Hptm. Arthur Schoeller, who, it may be remembered, had taken command of the R.28 after the loss of R.27 his previous aircraft. It was the evening of 15 September 1918 and the R.28 had just taken-off on a raid when a piston rod broke and the engine was immediately stopped. As sometimes happens, one failure follows another and, shortly thereafter, a cylinder burst in another engine. An emergency landing with the heavily-loaded aircraft was unavoidable. In spite of the pitch-black darkness, the landing would have been successful had not an engine continued inexplicably to run after its ignition had been cut. The R.28 ran into an escarpment and the fuselage broke in two. The crew managed to leave the aircraft just before it burst into flames and exploding bombs scattered the remains over a wide area.

A loss that was completely needless occurred while the R.38 was being delivered to the front. Its commander had been ordered to fly to Rea Cologne, with instructions to land at Hanover if for any reason the flight could not be continued. Circumstances had delayed the take-off at Döberitz, but the flight to Hanover went smoothly. Night was fast approaching, yet rather than break the flight at Hanover, the commander chose to fly through to Cologne. As night fell, he lost his orientation.

Instead of navigating by compass towards the Rhine, which would have guided him to Cologne, the commander decided to fly a more direct route over the Ruhr. The R.38 fired identification flares, and anti-aircraft batteries responded by signalling the direction of Cologne. Unfortunately these signals were not understood. After 5 hours in the air with fuel running short, it was decided to make an emergency landing on a country road cutting through hilly Rhineland terrain. The R.38 touched down safely, but during its landing run the wing hooked a high-tension tower. The aircraft turned 90 degrees, smashed into a cliff and was demolished. The majority of the crew perished.

POST-WAR OPERATIONS

The story of the R-plane did not end with cessation of hostilities. Although Rfa 501 was demobilized,[1] some of the giants continued to serve Germany in various civil and political roles until



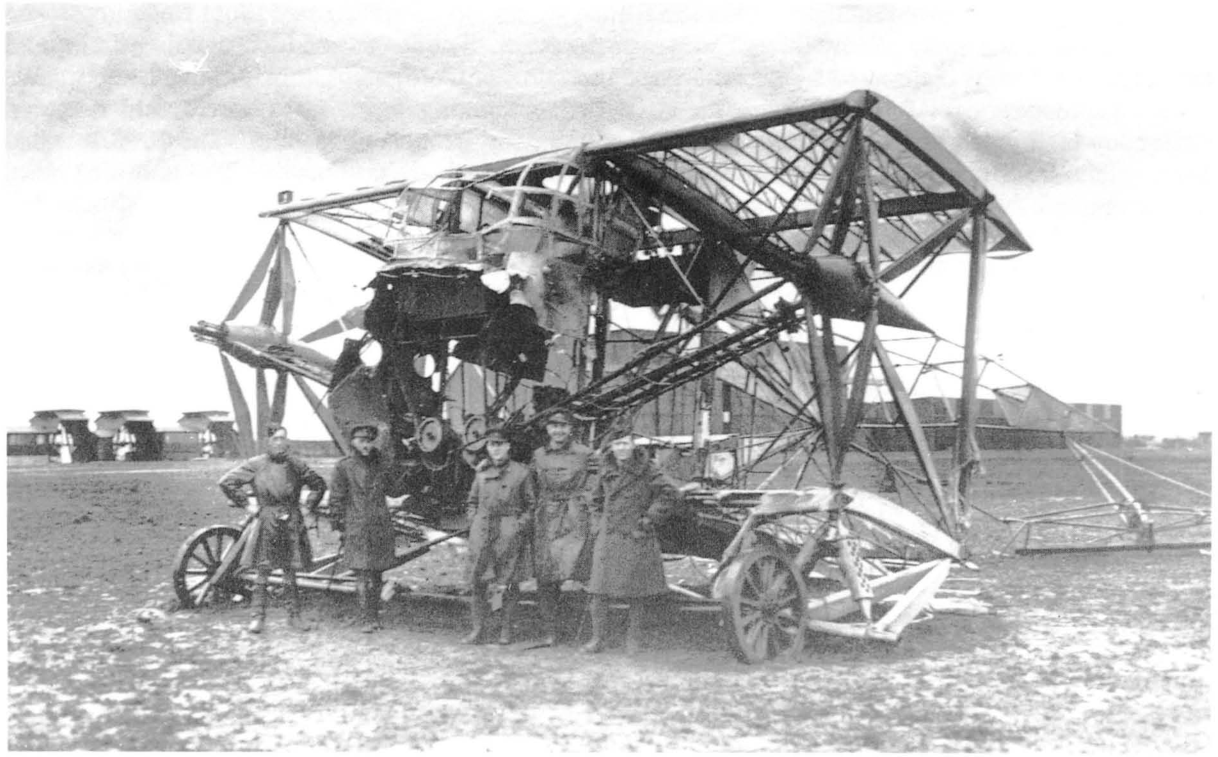
The Staaken R.IV 12/15, at Kassel, April 1919.

further activity was forbidden by the Treaty of Versailles. At the end of the war a number of the operational and training R-planes were destroyed or dismantled to prevent them from falling into Allied hands. British troops entering the outskirts of Ghent found three wrecked Staaken machines at one airfield, and two R-planes, a Staaken, and a SSW, were found demolished in Cologne. However, a small number of the newer machines and those on the verge of entering service were saved from destruction and flown to Liegnitz in Germany out of reach of Allied occupation troops.

It is a little-known fact that R-plane construction did not cease with the end of the war, but was allowed to continue by sanction of the German post-war government. On 17 January 1919 Idflieg sent the following letter to the Demobilmachungsamt (Demobilization Office):

> As of 31 January 1919 a number of R-planes will have reached a state of completion that would require only a small amount of time and effort to prepare them for flight. Inasmuch as the completion costs are negligible compared to the total expenditures thus far, it is recommended that these aircraft be finished. As such they will possess a tangible value because: (1) the aircraft can be used as civil air transports, and (2) foreign and domestic enterprises have inquired about buying these aircraft, which means that a portion of the construction costs would be recovered.
>
> In view of the above, the completion work cannot be classified as the manufacture of war material, but rather represents the production of transport equipment for peaceful purposes. In this regard the removal of weapons and bomb racks has already been ordered, and modifications for civil purposes have been permitted as long as they do not increase the completion costs.

[1] The combined Rfa 500 and Rfa 501 were demobilized in early 1919 at Düsseldorf. In October 1918, some personnel and aircraft had been moved to Düsseldorf to continue operations from nearby Lohausen airfield, but the war ended before any missions were flown.

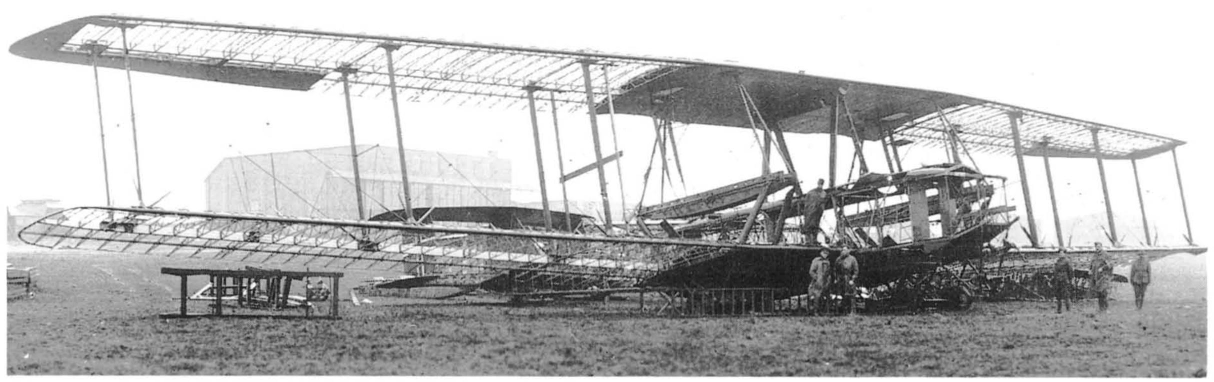


British officers standing in front of the wreckage of a SSW R-plane at Cologne airfield after the Armistice.

It is therefore requested that permission be granted to continue work after 31 January 1919 on those aircraft which have progressed to a point where their completion for civil use would be justified.

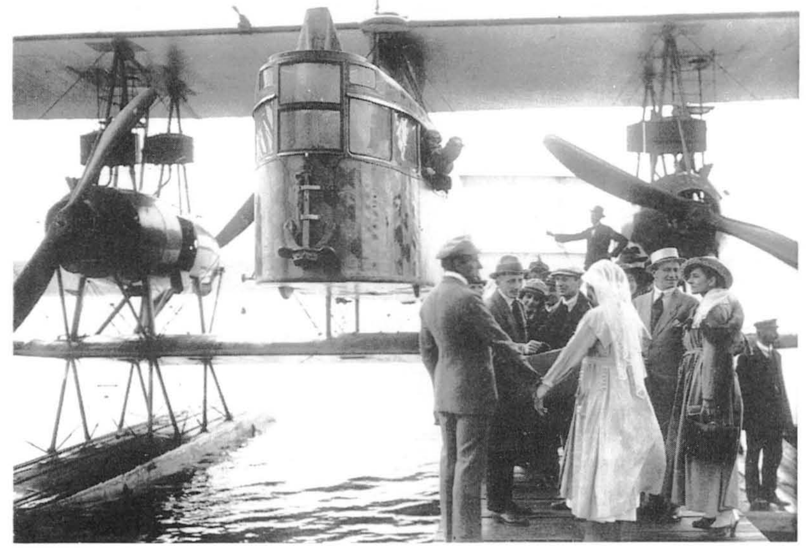
A list of the R-planes, their status and completion dates are presented in Appendix 11.

Within three days, on 20 January 1919, an answer was received from the Reichsverwertungsamt (Reich Evaluation Office), which agreed to the completion of the R-planes numbered R.56, R.84, R.85, R.86, R.51, R.18, R.19 and R.24 as emergency relief work. With this influx of hope, several aircraft companies, such as Aviatik, DFW and Linke-Hofmann, released publicity and specification sheets in an attempt to sell the R-plane as a new mode of transportation in the peacetime era, but not



Derelict Staaken R.XIV 44/17 left behind by the Germans at their abandoned airfield in Cologne, 11 February 1919.

one R-plane on the Idflieg list went into service as a transport. Actually, the majority were never completed, but scrapped. Outside of a few quasi-commercial passenger flights made by converted service R-planes, interest in the R-plane as a transport gradually waned. These flights were probably arranged more for their publicity value than anything else. The R.30, for instance, was hired by an English (or American) concern and, with the large inscription "Fletcher's World" painted on nose and fuselage, took passengers on joy-rides over Berlin. Late-model Staaken machines were photographed taking-on luggage-carrying civilians, but their destination is not known. The Staaken 8301 and 8303 seaplanes also enjoyed a brief fling as passenger transports and flew as many as 24 passengers between Swinemünde on the Baltic coast and Berlin on regular weekend service, landing and taking off from the Havel Lakes near Berlin. An unusual civil role was the appearance of a Staaken R.XIV in the film, "Tempel der Astarte", in which it carried adventurers to a fictitious land of gold. These civil flights were hardly mentioned in the voluble and nationalistic German aviation press, which

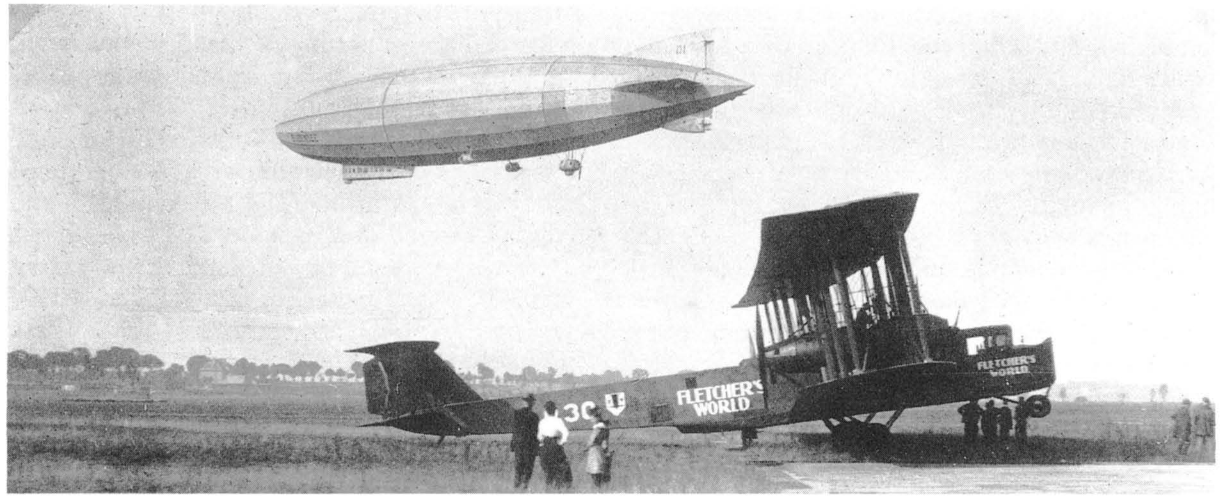


Staaken 8301 Seaplane with passengers, at the time it was operating week-end flights between Berlin and Swinemünde.

brings one to the conclusion that civilian R-plane travel was brief and unimportant. Germany, bled white by the war, did not possess the resources to support these expensive and experimental ventures. Nor were the Allies favourably disposed to see potential bombers cruising about in European skies. As a result, these machines soon joined others rotting in the scrapyard.

The R-plane did, however, participate in one final post-war political venture. In March 1918 the German–Russian peace treaty of Brest-Litovsk had established the Ukraine as an autonomous state under the protective wing of German power politics. After the Armistice in 1918 Austro-German troops withdrew from the Ukraine, leaving a vacuum into which rushed various Russian and Polish armies struggling for supremacy. The Ukraine turned to Germany for support; it required money to pay for its fight for independence, and the Ukrainian Government arranged to have 3·5 million in currency printed in Berlin. The problem remained how to deliver the currency safely through Poland, Czechoslovakia and Rumania, countries hostile towards Germany. To make the attempt by road or railway was considered to be too risky.

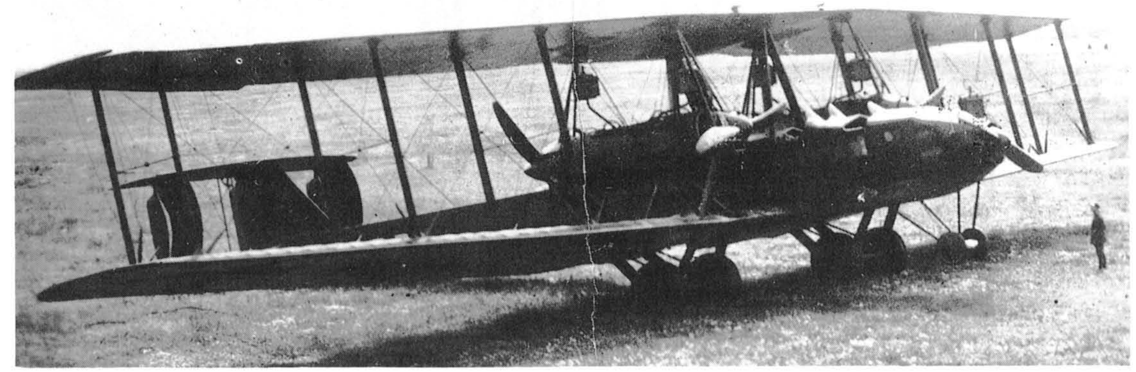
The only remaining access was by air, which coincided with the German Government's desire to find employment for the R-planes it still possessed. Consequently, it was decided that the currency would be delivered by R-planes, which would fly over hostile territory directly to the Ukraine. Klickermann, a former crew member of the R.39, volunteered to go to Kamenets-Podolskiy to prepare an airfield and service base in anticipation of the currency flights. In June 1919 the former crew of the R.13 consisting of Pickerott, commander; Waldemar Roeder and Schmitz, pilots; Kaffka, mechanic; and



The Staaken R.VI 30/16, in civil guise after the war. The airship overhead is the *Bodensee*.

carrying Klickermann as wireless operator flew in the R.70 from Breslau (Hundsfeld airfield) non-stop to the wheat-stubble field at Kamenets-Podolskiy. Emergency airfields had been established at Gliewitz and Kaschau, the Czech Government having given the Germans special permission to use the latter field. The first trip was not without its moments of danger. Over the Jablonica Pass in the Beskid Mountains an engine cover tore loose and threatened to fly into the rear propeller. A mechanic climbed out on the wing, secured the flapping cover and the flight continued without further event. At Kamenets-Podolskiy it was virtually impossible to secure fuel, oil and other supplies, but Klickermann managed to trade Ukrainian sugar and alcohol to the Rumanians for fuel; in the best traditions of graft, it had to be paid for a second time before the fuel was finally delivered.

Civilian passengers boarding a Staaken R.XIVa. Note the parachute shock cord running from the rear exit to the parachute compartment.



Staaken R.XIVa 70/18, chartered by the Ukrainian Government. Photo dated 14 June 1919.

At least four R-planes participated in the currency flights, but the number of trips made is unknown. The R.69, after successfully delivering its cargo of currency, was on its homeward trip to Berlin when a reduction gear failed. This prevented it from crossing the Tatra range and first pilot Vizefeldwebel Arnold was forced to land at Aspern, an airfield outside of Vienna on 29 July 1919. It was promptly confiscated by the Allies. The R.69 was carrying twenty-two passengers, including fifteen members of a Ukrainian legation, two returning German prisoners of war and surely the strangest cargo ever carried by an R-plane—a Russian honeymoon couple! The contemporary press stated that the R.69 was handed over to the Italians. In early February 1920, after standing in the open for six months at Aspern, the R.69 was completely destroyed by storm winds.

On 19 September 1919 the R.70 took-off from Breslau for Kamenets-Podolskiy. Weather conditions worsened over the Carpathians, and the aircraft was blown off course over Bessarabia, on realizing this the crew corrected their course, but before they were clear of Rumanian territory all five engines spluttered to a stop. In his apprehension Kaffka, the mechanic, had forgotten to switch fuel tanks. The R.70 made an emergency landing in a cornfield. The crew, consisting of two officers and three mechanics, were taken prisoner, and a press for printing bank-notes plus a quantity of jewels *en route* to the Ukraine were confiscated by the Rumanians. Waldemar Roeder recalls that the Rumanian authorities endeavoured to use the R.70 and its crew as a bargaining point for the return into their hands of a Rumanian Army colonel who had deserted to the Germans. In March 1920 the crew escaped from prison and eventually made their way back to Germany.

The R.71 was flown as a transport between Germany and the Ukraine. On 4 August 1919 it crashed and burned of unknown causes in the forest near Ratibor, Upper Silesia. Witnesses reported that the machine was shot down by Polish border troops. The R.71, piloted by Bendereich, was operated by the government-owned Deutsche Luft Reederei (DLR-German Air Shipping Line) and had been chartered by the Ukrainian Government. The crew of seven and two members of the Ukrainian finance commission, Lt. Tschutschmann and Capt. Vitorsky, the former Minister of War, perished in the crash. Scattered around the wreckage were found quantities of currency notes, several bags of Russian gold coins and important documents.

It is now known that the R.69, R.70 and R.71 were in the service of the DLR and carried the German civil registrations D-129, D-130 and D-131 respectively. After the demise of the R-plane, the currency flights were continued by the DLR using converted Friedrichshafen twin-engined bombers.

APPENDIX 1

Flight Log of Staaken R.V 13/15

(From the time Vzfw. Schmitz joined the R.V as pilot)

Flight No.	Crew	Purpose	Departure			Highest altitude (m.)	Route flown	Landing			Distance flown (km.)	Duration (hrs.)	Remarks
			Airfield	Date	Time			Airfield	Date	Time			
1	8	Altitude	Staaken	22.9.17	9:29	4500	over Staaken	Staaken	22.9.17	10:59	180	1:20	
2	,,	Acceptance	,,	26.9.17	7:48	4500	over Leipzig	,,	26.9.17	11:48	400	4:00	
3	,,	Delivery	,,	1.10.17	2:00	2000	over Berlin	Döberitz	1.10.17	3:30	140	1:30	
4	,,	Test	Döberitz	15.10.17	8:41	1500	over Döberitz	,,	15.10.17	9:08	36	0:27	
5	9	,,	,,	17.10.17	16:30	1900	,,	,,	17.10.17	17:08	78	0:38	
6	8	Altitude	,,	26.11.17	11:11	4500	,,	,,	26.11.17	12:45	215	1:34	
7	,,	Test	,,	28.11.17	12:05	2500	,,	,,	28.11.17	12:50	110	0:45	
8	14	,,	,,	4.12.17	15:35	3100	,,	,,	4.12.17	4:35	150	1:00	
9	11	Night	,,	5.12.17	23:57	2000	,,	,,	5.12.17	0:36	80	0:39	
10	,,	Transfer	,,	10.12.17	9:43	3900	over Halberstadt	Cologne	10.12.17	16:50	470	7:07	
11	,,	,,	Cologne	23.12.17	14:23	2700	over Aachen	St. Denis	23.12.17	16:34	240	2:11	
12	12	Test	St. Denis	6.1.18	16:30	1300	St. Denis	,,	6.1.18	16:59	75	0:29	
13	8	,,	,,	25.1.18	13:16	—	,,	,,	25.1.18	13:21	—	0:05	
14	,,	,,	,,	25.1.18	15:27	—	,,	,,	25.1.18	16:10	—	0:43	
15	,,	Mission	,,	25.1.18	21:25	3500	Calais-Ostende	Scheldewindeke	26.1.18	2:05	480	4:40	Target Calais and Dunkirk, 1090 kg. bombs, over Calais left nacelle gearing failed, left rear engine crankshaft broke, lights failed.
16	,,	Transfer	Scheldewindeke	28.1.18	11:12	—	over Ghent	St. Denis	28.1.18	11:25	—	0:13	
17	,,	Test	St. Denis	5.3.18	16:01	2400	,,	,,	5.3.18	17:01	148	1:00	
18	,,	Transfer	,,	6.3.18	16:30	1100	,,	Scheldewindeke	6.3.18	17:02	15	0:32	
19	,,	Mission	Scheldewindeke	7.3.18	23:05	3300	Ostend-London	,,	8.3.18	6:05	730	7:00	Target London, 1200 kg. bombs, after two hours flight right front clutch burned out. Engine stopped.
20	9	,,	,,	12.3.18	19:36	3400	Bruges-Boulogne	,,	12.3.18	23:35	475	3:59	Target Boulogne, 2000 kg. bombs, right front engine rpm too high, housing fractured, engine stopped. Left rear engine seized a piston, engine stopped.
21	8	Test	,,	20.4.18	10:53	3900	over Scheldewindeke	,,	20.4.18	12:27	195	1:34	
22	,,	Mission	,,	20.4.18	22:38	900	Ypres	,,	21.4.18	0:23	225	1:45	Target Ypres, 2160 kg. bombs, machine refused to climb, crossed front at 600 metres. Received 19 hits, aircraft returned without dropping bombs.
23	,,	Test	,,	25.4.18	11:18	—	over Ath	,,	25.4.18	13:18	260	2:00	
24	,,	,,	,,	8.5.18	14:22	—	over Brussels	,,	8.5.18	15:45	380	1:23	
25	,,	Mission	,,	9.5.18	1:18	2700	Ostende-Calais	,,	9.5.18	4:00	380	2:42	Target Calais, 1600 kg. bombs.
26	,,	Test	,,	17.5.18	9:43	700	over Scheldewindeke	,,	17.5.18	10:01	—	0:18	
27	,,	Mission	,,	19.5.18	22:24	3300	London	,,	20.5.18	4:06	730	5:42	Target London, 1100 kg. bombs.
28	,,	Test	,,	23.5.18	10:24	1600	over Scheldewindeke	,,	23.5.18	11:36	120	1:12	
29	,,	Mission	,,	27.5.18	22:38	3400	Abbeville	,,	28.5.18	2:38	420	4:00	Target Abbeville 1200 kg. bombs.
30	,,	,,	,,	29.5.18	22:50	3800	,,	,,	30.5.18	3:17	420	4:27	Target Abbeville 1400 kg. bombs.
31	,,	,,	,,	31.5.18	23:14	3300	St. Omer	,,	1.6.18	2:03	265	2:49	Target St. Omer 1300 kg. bombs.
32	,,	Test	,,	6.6.18	9:37	1100	over Scheldewindeke	,,	6.6.18	10:04	—	0:27	
33	9	Mission	,,	30.6.18	22:23	3400	Dieppe	,,	1.7.18	5:15	840	6:52	Target Dieppe 1200 kg. bombs.
34	8	Test	,,	30.7.18	7:02	2000	over Ghent	,,	30.7.18	8:17	130	1:15	
35	,,	,,	,,	1.8.18	17:44	3000	over Brussels	,,	1.8.18	19:16	140	1:32	
36	8	Mission	,,	10.8.18	17:42	3600	Doullens	,,	11.8.18	0:53	540	3:11	Target Doullens, 1500 kg. bombs.
37	,,	,,	,,	11.8.18	22:03	3100	Abbeville	,,	12.8.18	1:25	420	3:22	Target Abbeville, 1500 kg. bombs.
38	,,	,,	,,	13.8.18	—	3400	Rouen	,,	14.8.18	—	640	—	Target Rouen, 1100 kg. bombs.
39	,,	,,	,,	14.8.18	21:55	3600	,,	,,	15.8.18	3:10	640	5:15	Target Rouen, 1200 kg. bombs.
40	,,	Test	,,	23.8.18	9:03	—	over Scheldewindeke	,,	23.8.18	9:58	—	0:55	
41	,,	Mission	,,	24.8.18	22:04	3600	Gravelines	,,	25.8.18	1:37	475	3:33	Target Gravelines, 1300 kg. bombs.
42	,,	,,	,,	3.9.18	21:17	3400	Abbeville	,,	4.9.18	0:59	420	3:42	Target Abbeville, 1500 kg. bombs.
43	,,	,,	,,	28.9.18	0:28	—	—	,,	28.9.18	1:47	—	1:19	Mission cancelled, poor visibility, 1100 kg. bombs.
44	,,	,,	,,	29.9.18	1:46	—	—	,,	29.9.18	2:10	—	0:24	Mission cancelled, poor visibility, 1800 kg. bombs.
45	,,	Transfer	,,	2.10.18	13:07	1000		Morville	2.10.18	14:10	—	1:03	
46	,,	,,	Morville	18.10.18	—	—	—	Heistern	18.10.18	—	—	—	Engines failed, R.13 crashed near Düren.

APPENDIX 2

Organization of R-plane Troops (As of May 1918)

The Riesenflugzeug Truppe (R-plane Troops) were directly under the command of the Inspektion der Fliegertruppen (Idflieg-Inspectorate of Aviation Troops) and was composed of:

A. The Kommando der Riesenflugzeugabteilungen (Kdo Rfa—Commander of R-plane Sections) at Berlin.

B. The Riesenflugzeugersatzabteilungen (Rea—R-plane Support Sections) at Döberitz and Cologne.

C. The Riesenflugzeugabteilungen (Rfa—R-plane Squadrons) at the front.

A. KOMMANDO DER RIESENFLUGZEUGABTEILUNGEN (Kdo Rfa)

The Kdo Rfa was attached to Idflieg with its headquarters in Berlin under the command of Rittmeister Frhr. von Könitz. Kdo Rfa consisted of an administrative branch in charge of the personnel of the R-plane Troops, their book-keeping, etc., and a bureau to purchase and distribute raw materials which acted independently of a similar bureau at the War Office.

B. RIESENFLUGZEUGERSATZABTEILUNGEN (Rea)

The Rea was formed at the end of 1915 in Döberitz near Berlin. In January 1918, this section was divided into Rea Döberitz and Rea Cologne. The Rea Döberitz consisted of:

1. An officer and engineering staff, an inspection branch and a training command (R-Schulkommando).
2. The Rüstlager der Rea (stores depot) for the supply of spare parts, armaments, instruments, etc.
3. A Garnisonskompagnie (garrison company) of about 150 men for the supply of orderlies, store-keepers, transport drivers, etc.

The Rea Cologne was formed in January 1918 by the transfer from Döberitz to Cologne of part of the Rea. It was under the command of Hptm. Zimmer-Vorhaus, Stellvertretender Kommandeur der Rea (Deputy Commander of the Rea). Rea Cologne was stationed at the Cologne–Bickendorf airfield, where formerly a school for observers and combat training was located. Rea Cologne was comprised of three companies:

1. The Fliegerkompagnie (aviators' company) consisted of trained men ready to leave for the front, i.e. pilots of "C" and "D" machines, wireless operators, machine-gunners, mechanics, meteorologists, photographers and the like. The company organized finishing courses and had charge of crews of the R-planes undergoing tests after the delivery from the factory.
2. The Werftkompagnie (repair company) was in charge of the repair workshops and provided instructions for the riggers. It had a Schirrmeisterei (equipment store) which was responsible for maintaining a stock of spare parts and for the execution of repair work. About 100 of the 300-man company were mechanics.
3. The Ersatzkompagnie (reserve company) received the men who had just joined the Rea, carried out their training before passing them on to the Fliegerkompagnie and selected crews for assembling machines and performing acceptance tests. The man-power of the Ersatzkompagnie varied between 300 and 500 men.

C. THE RIESENFLUGZEUGABTEILUNGEN (Rfa)

The Rfa consisted of Rfa 500 and Rfa 501, the only R-plane squadrons formed during the war. As of May 1918, the effective strength of Rfa 501 was about 20 officers and 700–800 men of other ranks, organized as follows:

1. The Commanding Officer of the Squadron (Hptm. Richard von Bentivegni), who was in command of both the aircraft crews and maintenance gang. He was also responsible for the condition of the squadron's aircraft. His staff consisted of:

   (*a*) Two officers for special duty (Oblt. Glaassen and Lt. Ebert).
   (*b*) Two officers in charge of routine matters.
   (*c*) An intelligence officer (Lt. Braun).
   (*d*) A wireless officer (Lt. Henglein).
   (*e*) A medical officer.

2. The Fliegerkompagnie (aviators' company) consisted of the Reisenflugzeug Truppe (R-plane Troops) and the personnel of the "C" and "D" machines attached to the squadron. Attached to each R-plane was a Trupp consisting of a flight crew of two officers and seven men and a maintenance crew of about 20 men (1 foreman, 12 riggers, 2 fitters, 2 carpenters, 2 electricians, 1 or 2 saddlers and splicers). The Fliergerkompagnie numbered about 170–180 men.
3. Werftkompagnie (repair company) was commanded by the equipment officer (Lt. Fleischhauer) and included the following services:

   (*a*) Technisches Bureau (technical office) composed of engineers, designers, draftsman, clerks, etc.
   (*b*) Werftbetrieb (all workshops).
   (*c*) Schirrmeisterei (equipment store) responsible for acceptance and distribution of material.
   (*d*) Bildabteilung (photographic laboratory).

The next four services were commanded by the technical officer (Lt. Gasterstäd assisted by Engineer Lange):

4. Startdienst (starting command) responsible for the starting preparations, the positioning of guide-flares, etc. This command was under the orders of the equipment officer.
5. Wetterwarte (meteorological station) under the orders of the meteorological officer (Lt. Frhr. von Lenz).
6. Bombentrupp (bomb troop) in charge of the upkeep of bombs (Feldwebel Eilers).
7. Waffenmeisterei (armoury).
8. Depot consisting of fuel, equipment and tool stores and an instrument repair section.
9. Kraftfahrer (transport section) under the orders of Oblt. von Seydlitz-Gerstenberg.
10. Blinkfeuerkommando (flare command) was in charge of illuminating the airfield, blinker signalling, etc. It was under the orders of the intelligence officer.
11. Kassenverwaltung (pay office).
12. Other detachments attached to Rfa 501 included wireless, telephone and searchlight operators, and an anti-aircraft section under the orders of an acting officer.

In May 1918 Rfa 501 had five R-planes and about 20 "C" and "D" aircraft at its disposal. The "C" and "D" machines were used as navigation trainers, communication aircraft, etc. In principle, three "C" and "D" machines were assigned to each R-plane and were serviced by its maintenance crew. The five or six remaining aircraft were serviced by a special detachment of twelve fitters attached to the Fliegerkompagnie. Lt. Götte was in charge of the "C" and "D" aircraft service.

APPENDIX 3

List of German Army Air Service Officers who died while attached to R-plane Units

Name and rank	Unit	Date	Locality	Aircraft
Oblt. Hans. Frhr. Haller von Hallerstein	500	13 Nov. 1916	Friedrichshafen	Single-seater
Lt. Franz Krüger	F 500	24 Jan. 1917	Alt-Auz	R.10
Oblt. Willibald Reibedanz	B 500	24 Jan. 1917	Alt-Auz	R.10
Vzfeldw. Hans Vollmöller (1)	F Rea	10 Mar. 1917	Staaken	VGO.I
Oblt. Fritz Ladewig	B Rea	31 May 1917	Halle a. S.	
Lt. d. R. Erich Steffens	F Rea	31 May 1917	Halle a. S.	
Lt. Karl Plagemann	B 500	19 Aug. 1917	Halberstadt	R.14
Oblt. Efrem Rosetti-Solescu	F 500	19 Aug. 1917	Halberstadt	R.14
Lt. d. R. Hans Dankwardt	B Rea	6 Sept. 1917	Nowosolki	
Lt. d. R. Friedrich Oetling	B Rea	4 Mar. 1918	Döberitz	Two-seater
Oblt. Helmut Schneider	B Rea	4 Mar. 1918	Döberitz	Two-seater
Lt. d. R. Robert Jacobi	B Rea	11 Mar. 1918	Frankfurt a. d. O.	
Oblt. Hans Sturm	F 501	21 Apr. 1918	Westroosebeke	R.34
Lt. d. R. Martin Böhme	B 501	21 Apr. 1918	Westroosebeke	R.34
Oblt. Johannes Leistner	B 501	21 Apr. 1918	Westroosebeke	R.34
Oblt. Hans Thümmler	B Rea	6 May 1918	Heisingen	R.38
Lt. d. R. Waldemar Potempa	F Rea	6 May 1918	Heisingen	R.38
Lt. d. R. Karl Freund	F 501	10 May 1918	Scheldewindeke	(2)
Lt. d. R. Wilhelm Landwehrmann	F 501	10 May 1918	Scheldewindeke	(2)
Hptm. Fritz Wieter	B 501	10 May 1918	Scheldewindeke	(2)
Lt. d. R. Lothar Friedrich	F 501	10 May 1918	Scheldewindeke	(2)
Oblt. Fritz Pfeiffer	B 501	10 May 1918	Scheldewindeke	R.26
Lt. d. R. Wilhelm Pier	F 501	10 May 1918	Scheldewindeke	R.26
Oblt. Hans-Joachim von Seydlitz-Gerstenberg	F 501	26 July 1918	Scheldewindeke	Two-seater
Lt. d. L. Johannes Braun	B 501	11 Aug. 1918	Talmas	R.43
Lt. Theodor Corty	F 501	11 Aug. 1918	Talmas	R.43
Hptm. Erich Schilling	F 500	12 Aug. 1918	Villers la Tour	R.52
Lt. d. R. Otto Reichardt		3 Sept. 1918	Rudow b. Berlin	R.21
Oblt. Brückmann		3 Sept. 1918	Rudow b. Berlin	R.21
Lt. d. R. Oskar Wittenstein	F FM	3 Sept. 1918	Rudow b. Berlin	R.21
Lt. d. R. Werner Kathol	F Rea	26 Sept. 1918	Cologne	
Rittm. Hans Balthazar	B Rea	17 Oct. 1918	Bonn	

F Flugzeugführer. (Pilot)
B Beobachter. (Observer)
FM Flugzeugmeisterei. (Aircraft Section at Idflieg)
(1) Non-commissioned officer.
(2) R.26, R.29 and R.32, all crashed on 10 May 1918.

APPENDIX 4

Operational Missions of Rfa 501 (Eastern Front)

The following is an incomplete list of missions flown by Rfa 501 from Vilna as pieced together from available documents:

Aircraft	Date	Target	Location	Bomb load dropped (kg).
SSW R.6	3 Sept. 1916	Railway station	Molodeczne	Unknown
SSW R.6	4 Sept. 1916	(3-hr. flight)		350
SSW R.5	14/15 Oct. 1916	Railway station	Wileyka	500
SSW R.5	26 Nov. 1916	Troop camp	Iza	Unknown
SSW R.5	7 Jan. 1917	Railway station	Poloczany	325
	19 Jan. 1917	Troop camp	Iza	712
SSW R.5	30 Jan. 1917	Railway station	Wileyka	844
SSW R.6	8 Feb. 1917	Railway station	Molodeczne	373
	12 Feb. 1917	Railway station	Zalesie	550
SSW R.6	2 Mar. 1917	Railway station	Zalesie and Molodeczne	590
SSW R.7	7 Mar. 1917	Railway station	Wilekya and Molodeczne	590
	16 Mar. 1917	Troop camp	Iza	560
	1 Apr. 1917	Town	Naracz	600
SSW R.4	5 Apr. 1917	Railway station	Wileyka	600
SSW R.6	5 June 1917	Troop camp	Biala	760
SSW R.7	18 June 1917	Supply dump	Overky	600
	2 Aug. 1917	Railway station	Prudy	Reconnaissance

APPENDIX 5

Statistical Comparison of Bombengeschwader 3 and Rfa 501 during the England Raids

	Bombengeschwader 3	Rfa 501
Total number of raids	22	11
Total weight of bombs dropped	84,745 kg.	27,190 kg.
Percent of grand total (111,935 kg.)	75·7%	24·3%
Number of aircraft which dropped bombs on England	292	28
Average bomb load per aircraft	290 kg.	977 kg.
Total loaded weight of Gotha G.IV and Staaken R.VI	3,655 kg.	11,848 kg.
Average bomb load as a percentage of total weight	7·96%	8·24%
Number of aircraft which took-off	383	30
Number of aircraft completing mission	292	28
Percent of aircraft completing mission	76·4%	93·4%
Number of aircraft lost to enemy action	24	0
Number of aircraft lost to accidents	37	2
Total number of aircraft lost	61	2
Percent of aircraft lost	15·9%	6·7%
Average number of aircraft lost per raid	2·78%	0·18

APPENDIX 6

Chart of R-plane Raids on England

Day and weather	Number of aircraft A. Started B. Dropped bombs on England	Targets A. Intended B. Actual	R-plane bomb load ex. = Explosive inc. = Incendiary	Total casualties	Cost of damage (pounds sterling)	Remarks and R-planes taking part in raid
28/29 September 1917 Heavy cloud formation	A. 25 G-types 2 R-planes B. 3 G-planes 2 R-planes (1)	A. London B. London Sheerness	1800 kg. (ex.)	None	129	First R-plane raid on England R.12 R.33 turned back
29/30 September 1917 Poor visibility due to clouds	A. 7 G-types 3 R-planes B. 4 G-types 3 R-planes	A. London B. London Sheerness	2700 kg. (ex.)	14 killed 87 injured	23,154	R.25, R.26, R.39 R.12 bombed Gravelines
6 December 1917 No wind, clear, half moon	A. 19 G-types 2 R-planes B. 16 G-types 2 R-planes	A. London B. Sheerness Margate Dover	1200 kg. (ex.) 820 kg. (inc.)	8 killed 28 injured	103,408	R.39
18 December 1917 Weak moon, good visibility	A. 15 G-types 1 R-plane B. 13 G-types 1 R-plane	A. London B. London	600 kg. (ex.) 400 kg. (inc.)	14 killed 83 injured	238,861	R.12
22/23 December 1917 Hazy, poor visibility	A. 2 R-planes B. 2 R-planes	A. Coast of Kent B. Thames Estuary	2000 kg. (ex.)	None	—	R.12, R.39
25 December 1917	Three R-planes started for England, but bombed Boulogne instead, due to fog.					
28/29 January 1918 Clear with danger of fog	A. 13 G-types 1 R-plane B. 7 G-types 1 R-plane	A. London B. London	1200 kg. (ex.)	67 killed 166 injured	187,350	
29/30 January 1918 Slight haze, fair visibility	A. 4 R-planes B. 3 R-planes	A. London B. London Southend	3000 kg. (ex.)	10 killed 10 injured	8,968	One R-plane turned back due to engine failure
16/17 February 1918 Poor weather, overcast	A. 5 R-planes B. 5 R-planes	A. London or Coastal Cities B. London Deal Dover	4250 kg. (ex.)	12 killed 6 injured	19,264	First 1000 kg. bomb dropped by R.39 R.25, R.36 attacked Dover R.33 prematurely attacked warships at Deal due to engine failure R.12 attacked Woolwich Works
17/18 February 1918 Hazy, but good visibility	A. 1 R-plane B. 1 R-plane	A. London B. London	1000 kg. (ex.)	21 killed 32 injured	38,922	R.25 hit by A.A. fire several times
7/8 March 1918 High wind, partially cloudy	A. 6 R-planes B. 5 R-planes	A. London B. London Sheerness Margate	5020 kg. (ex.)	23 killed 39 injured	42,655	Second 1000 kg. bomb dropped by R.39 R.27 and one other R-plane crash landed in Belgium R.13
9/10 May 1918	Four R-planes started for Dover, but French coastal cities bombed instead, due to weather.					
19/20 May 1918 Cloudy, but London clear	A. 38 G-types 2 C-types 3 R-planes B. 18 G-types 2 C-types 3 R-planes	A. London B. London Chelmsford	3200 kg. (ex.)	49 killed 177 injured	177,317	Third 1000 kg. bomb dropped by R.39 on Chelmsford R.13

Note: The German official air services information bulletin stated that one R-plane dropped 900 kg. bombs on London on 1/2 October 1917. Von Bülow's study does not mention this. It is known that the R.39 was in the air on this night, but the list of raids painted on its nose after the war does not include this raid.

(1) War diary shows only one R-plane bombed London.

APPENDIX 7

Operational Missions of Rfa 500 and Rfa 501 (Western Front)

List of known targets bombed by R-planes in France and Belgium as pieced together from available documents.

Squadron	Date	Target
Rfa 501	Nov. 1917	Dunkirk
Rfa 501	22/23 Dec. 1917	Boulogne
Rfa 501	25 Dec. 1917	Boulogne
Rfa 501	25/26 Jan. 1918	Calais
Rfa 501	12/13 Mar. 1918	Boulogne
Rfa 501	20/21 Mar. 1918	Boulogne
Rfa 501	1 Apr. 1918	Boulogne
Rfa 501	20/21 Apr. 1918	St. Omer
Rfa 501	7/8 May 1918	Abbeville
Rfa 501	8/9 May 1918	Calais
Rfa 501	9/10 May 1918	Dunkirk, Calais
Rfa 501	23 May 1918	Abbeville
Rfa 501	24 May 1918	Boulogne
Rfa 501	26 May 1918	Abbeville
Rfa 501	27/28 May 1918	Abbeville
Rfa 501	29/30 May 1918	Abbeville
Rfa 500	30 May 1918	Dunkirk
Rfa 500	31 May 1918	Creil, St. Just, Compiegne
Rfa 501	31 May 1918	Etaples, St. Omer
Rfa 500	1 June 1918	Meaux
Rfa 500	1/2 June 1918	Paris
Rfa 501	5/6 June 1918	Boulogne, Calais
Rfa 501	30 June 1918	Amiens, Dieppe
Rfa 501	1 July 1918	Dieppe
Rfa 501	11 July 1918	Doullens
Rfa 501	13 July 1918	Arras
Rfa 501	15 July 1918	Rouen
Rfa 501	30 July 1918	le Havre
Rfa 501	14 Aug. 1918	le Havre, Rouen, Abbeville
Rfa 500	14 Aug. 1918	Meaux
Rfa 501	10/11 Aug. 1918	Doullens
Rfa 500	11/12 Aug. 1918	Beauvais
Rfa 501	11/12 Aug. 1918	Arras, Abbeville
Rfa 501	13/14 Aug. 1918	Rouen
Rfa 501	14/15 Aug. 1918	Rouen
Rfa 501	16 Aug. 1918	Rouen
Rfa 501	24/25 Aug. 1918	Gravelines
Rfa 501	—	Poperinghe
Rfa 501	4/5 Sept. 1918	Abbeville
Rfa 500	15/16 Sept. 1918	Le Havre

APPENDIX 8

Performance of R-planes on Combat Missions

Dr.-Ing. Adolf Rohrbach, the designer of the Staaken E.4/20, compiled the following statistical material on the combat missions flown by R-planes. He used these figures in 1920 to prepare a study on the theoretical safety factor of multi-engined aircraft.

RECORD OF R-PLANE COMBAT MISSIONS

Type	Location	Number of Aircraft	Number of missions			Weight of bombs	
			Begun	Completed	Not Completed	Total	Ave./mission
Staaken	East Front	4	21	18	3	15,485 kg.	860 kg.
	West Front	16	102	94	8	103,932 kg.	1110 kg.
	Total	20	123	112	11	119,417 kg.	970 kg.
Siemens	East Front	4	23	20	3	9,425 kg.	470 kg.
DFW	East Front	1	1	1	—	680 kg.	680 kg.

Note: This chart does not show total missions flown.

SELECTED R-PLANE COMBAT MISSIONS

(Showing increase in useful load during the war)

Date	Type	Useful load	Ceiling	Duration
13 Aug. 16	VGO.II 9/15	2296 kg.	2500 m.	3 hr. 30 min.
16 Aug. 16	VGO.II 9/15	2507 kg.	over 1900 m.	2 hr. 27 min.
22 Sep. 16	VGO.III 10/15	3310 kg.	over 3000 m.	3 hr. 10 min.
9 Sep. 17	Staak R.IV 12/15	4306 kg.	3600 m.	3 hr. 48 min.
18 Dec. 17	Staak R.IV 12/15	4434 kg.	2900 m.	5 hr. 40 min.
25 Jan. 18	Staak R.V 13/15	4727 kg.	3500 m.	4 hr. 35 min.
8 Mar. 18	Staak R.V 13/15	4771 kg.	3300 m.	6 hr. 40 min.[1]
1 July 18	Staak R.VI 31/16	4789 kg.	1900 m.	4 hr.

[1] The R.13 war diary shows a duration from take-off to landing of seven hours.

COMPILATION OF USEFUL LOAD VERSUS MISSIONS FLOWN

Useful load	Number of missions
Between 3850 kg. and 4000 kg.	12
Between 4000 kg. and 4200 kg.	15
Between 4200 kg. and 4400 kg.	14
Between 4400 kg. and 4600 kg.	30
Between 4600 kg. and 4700 kg.	7
Between 4700 kg. and 4800 kg.	10

COMPILATION OF FLIGHT DURATION VERSUS MISSIONS FLOWN

Duration	Number of Missions
Between $2\frac{1}{2}$ and 3 hr.	4
Between 3 and 4 hr.	20
Between 4 and 5 hr.	33
Between 5 and 6 hr.	20
Between 6 and 7 hr.	8
Between 7 and 8 hr.	3

Greatest Duration 7 hr. 50 min.

COMPILATION OF ALTITUDE VERSUS MISSIONS FLOWN

Altitude	Number of missions
Between 1600 m. and 2000 m.	4
Between 2000 m. and 2400 m.	11
Between 2400 m. and 2800 m.	24
Between 2800 m. and 3200 m.	30
Between 3200 m. and 3600 m.	16
Between 3600 m. and 4000 m.	5
Between 4000 m. and —	1

Note: Out of twenty-one of eighty-eight completed Western Front missions, one engine failed or had to be stopped without being able to start it again during mission. On five of these twenty-one missions engine stoppage occurred on the outward-bound flight. On six other missions it was possible to repair severe engine defects such as cooling system damage, fuel line ruptures, valve and ignition failures. These defects either stopped or would have stopped the engine, but in-flight repairs made it possible to run the engine for the remainder of the mission. On three other missions the engine failed after repairs had been performed.

TYPES OF FAILURES EXPERIENCED ON 110 COMBAT MISSIONS OF RFA 501 FLYING STAAKEN R-PLANES

Type of failure	Total number of failures
Enemy action	4
Instrument failure	8
Engines	21
Radiators	8
Fuel system	3
Reduction gears	9

APPENDIX 9

Operational R-plane Losses

(Only those R-planes which were completely written-off are included)

	Aircraft	No.	Date lost	Reason for loss	Location	Unit	Officers lost
1.	VGO.III	R.10	24 Jan. 1917	Wind gust and landing on snow-covered airfield	Alt-Auz	Rfa 500	2
2.	SSW R.V	R.5	Feb. 1917	Faulty landing	Eastern Front	Rfa 501	None
3.	Staak. R.VII	R.14	19 Aug. 1917	Engine failure on take-off	Halberstadt	Rfa 500	2
4.	DFW R.I	R.11	Sept. 1917	Emergency landing in fog due to engine failure	Alt-Auz	Rfa 500	None
5.	Staak. R.VI (Schül)	R.27	7/8 Mar. 1918	Emergency landing due to fuel failure	Belgium	Rfa 501	None
6.	Staak. R.VI	*	7/8 Mar. 1918	Emergency landing	Belgium	Rfa 501	None
7.	Staak. R.VI (Albs)	R.38	6 May 1918	Emergency landing on delivery flight	Heisingen	Rea	2
8.	Staak. R.VI	R.26	9/10 May 1918	Fog landing	Scheldewindeke	Rfa 501	6
9.	Staak. R.VI (Schül)	R.29	9/10 May 1918	Fog landing	Scheldewindeke	Rfa 501	
10.	Staak. R.VI	R.32	9/10 May 1918	Fog landing	Scheldewindeke	Rfa 501	
11.	Staak. R.VI (Av)	R.34	21 Apr. 1918	Crashed after combat	Westroosebeke	Rfa 501	3
12.	Staak. R.VI (Albs)	R.37	1/2 June 1918	Forced landing by A.A. fire	Betz	Rfa 500	None
13.	Staak. R.XIV	R.43	10/11 Aug. 1918	Shot down by 151 Sqdn. R.A.F.	Talmas	Rfa 501	2
14.	Staak. R.VI (Av)	R.52	11/12 Aug. 1918	Side-slipped and crashed	Villers la Tour	Rfa 500	1
15.	Staak. R.VI	R.31	15/16 Sept. 1918	Shot down by 151 Sqdn. R.A.F.	Beugny	Rfa 500	—
16.	Staak. R.XIV	R.45	15/16 Sept. 1918	Night landing, crashed into obstacle	Morville	Rfa 500	None
17.	Staak. R.VI (Schül)	R.28	15/16 Sept. 1918	Emergency landing due to engine failure	Chimay	Rfa 500	None

* **Believed to be R.36.**

APPENDIX 10

Projected Delivery Dates for R-planes

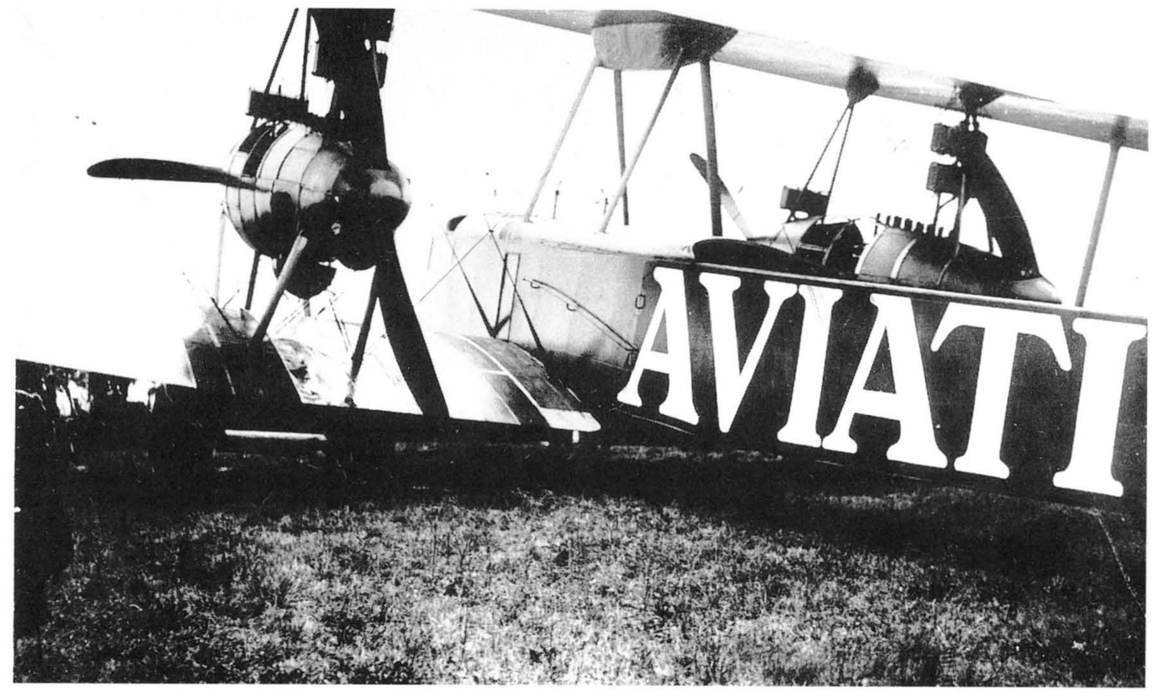
(Inspektion der Fliegertruppen, 15 March 1918)

Company	Ready for test flight	1 Apr.	15 Apr.	May	June	July	Aug.	Sept.	Oct.	Later
DFW				R.16	R.17	R.18	R.19			
AEG		R.21			R.22 R.59	R.60		R.61	R.62	R.63 R.64
SSW					R.23	R.24				
Staaken	R.43	R.44	R.45	R.46	R.47 R.48				R.201	R.202 R.203 R.206
Schütte–Lanz			R.28 R.29							
Aviatik			R.52	R.53	R.54	R.49	R.50	R.51		
Albatros		R.38								
Linke–Hofmann		R.40 R.41 R.42				R.55 R.56				
Junkers–Fokker					R.57		R.58			

APPENDIX 11

List of R-planes to be Completed after 31 January 1919

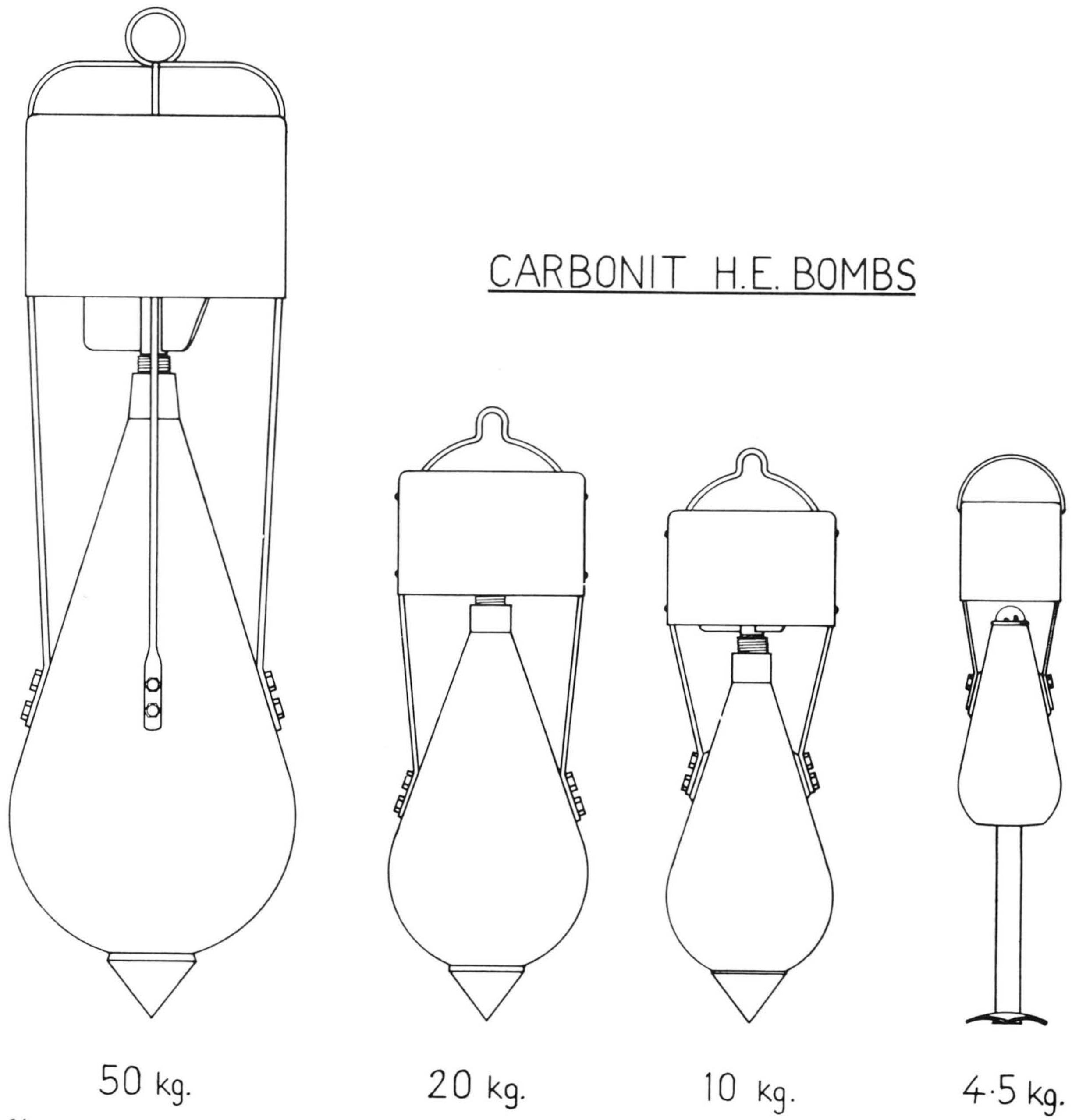
Constructor and aircraft	Total cost (marks)	Status on 15 Jan. 1919	Cost required to complete aircraft (marks)	Estimated completion date
Linke-Hofmann				
R.55	450,000	Ready for flight	—	31 Jan. 1919
R.56	450,000	Ready for delivery	*ca.* 10,000	31 Jan. 1919
Schütte-Lanz				
R.84	600,000	Assembly ¾ complete	*ca.* 100,000	15 Mar. 1919
R.85	600,000	Assembly ½ complete	*ca.* 125/150,000	15 Apr. 1919
R.86	600,000	Individual parts complete. Assembly begun	*ca.* 200,000	15 Apr. 1919
Aviatik				
R.50	530,000	Assembly ¾ complete	*ca.* 25,000	15 Feb. 1919
R.51	530,000	Assembly ¾ complete	*ca.* 50,000	15 Mar. 1919
DFW				
R.18	500,000	Almost completed	*ca.* 2,000	31 Jan. 1919
R.19	500,000	Almost completed	*ca.* 18,000	15 Feb. 1919
Siemens-Schuckert				
R.23	750,000	Ready for flight	—	31 Jan. 1919
R.24	750,000	Assembly ¾ complete	*ca.* 150,000	15 Mar. 1919



Staaken R.XVI(Av) 50/17, one of the R-planes completed after 31 January 1919, with company markings.

Short Description of German Bombs

The first German bomb specifically intended for aircraft use was known as the A.P.K. bomb, so named after the Artillerie-Prüfungs-Kommission (Artillery-Test Commission), the Army department which had originated this weapon. The A.P.K. bomb consisted simply of a circular cast-iron shell and an impact fuse. It was filled with high explosive and was produced in 5 kg. and 10 kg. sizes. The A.P.K. bomb, developed in 1912/13, was not used in the war.



In order to obtain a more effective weapon, experiments were performed which resulted in a series of bombs known as the Carbonit (or Karbonit) type, produced by Sprengstoff A.G. "Carbonit"-Schlebusch. This series of bombs had a tear-drop-shaped cast-iron body, a steel-tipped nose for better penetration, a ring-shaped stabilizing fin and a propeller-activated tail fuse. The Carbonit bomb, generally loaded with TNT, was produced in 4·5 kg., 10 kg., 20 kg. and 50 kg. sizes. All early R-planes were fitted to carry these bombs hung vertically in the bomb bay.

The Carbonit incendiary bomb was constructed from a blunt-nosed cylindrical sheet-steel container fitted with a tail fuse and a circular stabilizing fin. It was filled with a highly inflammable mixture consisting of one part benzol or petrol, five parts kerosene and a small quantity of liquid tar. The total weight of the bomb was 10 kg., of which 3·5 kg. represented the incendiary mixture. Due to the highly inflammable nature of the bomb, it was always filled shortly before take-off.

The Carbonit bombs were used by the Germans from the end of 1914 until 1916; although an improvement over the A.P.K. bomb, they oscillated too long after release and had a tendency to drift with the wind.

Another incendiary weapon which found use in the early years of the war was the Goldschmidt bomb. Filled with a mixture of benzol, tar and thermite, this incendiary burned at the then exceedingly high temperature of 3000° C. This weapon, very similar in shape to the Carbonit bomb, consisted of an inner iron cylinder filled with thermite, surrounded by a thin sheet metal container filled with 3·5 litres of benzol; the outer shell was wrapped with tarred rope, which prevented dispersion of the benzol. Its total weight was about 10 kg.

German P.u.W. high-explosive aerial bombs.

To overcome the shortcomings of the inaccurate Carbonit bomb, the Prüfanstalt und Werft der Fliegertruppe (P.u.W.—Test Establishment and Workshop of the Aviation Troops) and the optical firm of Goerz-Friedenau, a manufacturer of bomb-sights, co-operated in 1915 to develop the so-called P.u.W. bomb. This torpedo-like bomb had a superior aerodynamic performance and is considered by armament experts to be the true prototype of the modern aircraft bomb. It was manufactured from high-grade steel, rather than cast-iron, which gave it superior penetration power, and

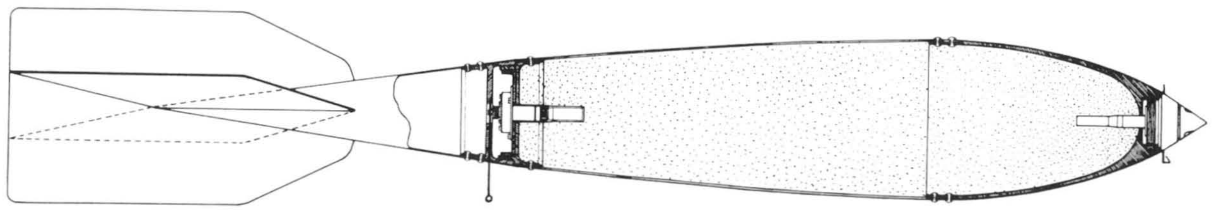
the tail fins were mounted at an angle to spin-stabilize the bomb during its trajectory and to activate the fuses by centrifugal force. The P.u.W. bombs were constructed in six different sizes as follows:

SPECIFICATIONS FOR P.u.W. BOMBS

Weight		Diameter		Length		Explosive weight Per cent of total	Number of fuses
kg.	lb.	mm.	in.	mm.	in.		
12·5	27·56	90	3·54	750	29·53	12	1
12·5*	27·56	140	5·51	850	33·47		1
50	110·25	180	7·09	1700	66·93	46	1
100	220·50	250	9·84	1900	74·80	60	2
300	661·50	365	14·37	2750	108·27	60	2
1000	2205·00	550	21·65	4005	157·68	68	2

* Incendiary

Note: The specifications above are from official tables, but sizes and weights did vary slightly for different production runs.



300 kg. P.u.W. BOMB

All P.u.W. bombs were horizontally suspended in the bomb bay; the larger bombs were hung by fore-and-aft cables from a simple rectangular frame in the bomb bay. The small 12·5 kg. bomb was carried in special magazines, each holding six bombs.

Rfa 500 ground crew loading a 300 kg. P.u.W. bomb.

APPENDIX 13

Chart of R-plane Numbers, Dimensions and Performance

ARMY AIRCRAFT

Designation				Engines				Propellers		Dimensions			Weights		Performance			
Factory	Type No.	Serial No.	Licence	No.	Manufacturer	Type	Total h.p.	Tractor	Pusher	Span (metres)	Length (metres)	Area (sq. metres)	Empty (kg.)	Loaded (kg.)	Speed (k.p.h.)	Climb (metres)	Climb (minutes)	Ceiling (metres)
SSW	R.I	R.1/15	—	3	Benz	Bz.III	450	2	—	28	17·5	138	4,000	5,200	110	2000	35	3700
SSW	R.II	R.2/15	—	3	Mercedes	D.IVa	780	2	—	38	18·5	233	6,150	8,460	110	3000	45	3800
SSW	R.III	R.3/15	—	3	Benz	Bz.IV	660	2	—	34·33	17·7	177	5,400	6,820	132	2000	35	3000
SSW	R.IV	R.4/15	—	3	Benz	Bz.IV	660	2	—	37·6	18	201	5,450	6,900	130	3000	104	3050
SSW	R.V	R.5/15	—	3	Benz	Bz.IV	660	2	—	34·33	17·7	177	5,300	6,766	132	3000	102	3000
SSW	R.VI	R.6/15	—	3	Benz	Bz.IV	660	2	—	33·36	17·7	171	5,250	6,800	132	2000	36	2950
SSW	R.VII	R.7/15	—	3	Mercedes	D.IVa	780	2	—	38·44	18·5	210	5,700	7,960	130	3000	66	3200
Li-Ho	R.I	R.8/15	—	4	Mercedes	D.IVa	1040	2	—	32·02	15·56	264	5,800	9,000	140	2000	25	—
VGO	VGO.II	R.9/15	—	3	Maybach	HS	720	1	2	42·2	23·78	332	6,637	10,203	110	2000	39	3000
VGO	VGO.III	R.10/15	—	6	Mercedes	D.III	960	1	2	42·2	24·5	332	8,600	11,600	120	3000	56	3000
DFW	R.I	R.11/15	—	4	Mercedes	D.IV	880	2	2	29·5	17·6	182	5,652	8,380	120	—	—	—
Staak	R.IV	R.12/15	—	6	2 Mercedes 4 Benz	D.III Bz.IV	1200	1	2	42·2	23·2	332	8,772	13,035	125	3000	89	3700
Staak	R.V	R.13/15	—	5	Maybach	Mb.IVa	1225	3	—	42·2	23	332	9,450	13,010	135	3000	34	4500
Staak	R.VII	R.14/15	—	6	2 Mercedes 4 Benz	D.III Bz.IV	1200	1	2	42·2	22·1	332	8,923	12,953	130	3000	50	3850
DFW	R.II	R.15/16	—	4	Mercedes	D.IVa	1040	2	2	35·06	20·93	266	8,634	11,693	135	2000	58	—
DFW	R.II	R.16/16	—	4	Mercedes	D.IVa	1040	2	2	35·06	20·93	266	9,032	12,642	—	—	—	—
DFW	R.II	R.17/16	—	4	Mercedes	D.IVa	1040	2	2	35·06	20·93	266	8,634	11,693	135	2000	58	—
DFW	R.II	R.18/16	—	4	Mercedes	D.IVa	1040	2	2	35·06	20·93	266	8,634	11,693	135	2000	58	—
DFW	R.II	R.19/16	—	4	Mercedes	D.IVa	1040	2	2	35·06	20·93	266	8,634	11,693	135	2000	58	—
DFW	R.II	R.20/16	—	4	Mercedes	D.IVa	1040	2	2	35·06	20·93	266	8,634	11,693	135	2000	58	—
AEG	R.I	R.21/16	—	4	Mercedes	D.IVa	1040	2	—	36	19·5	260	9,000	12,700	—	—	—	—
AEG	R.I	R.22/16	—	4	Mercedes	D.IVa	1040	2	—	36	19·5	260	9,000	12,700	—	—	—	—
SSW	R.VIII	R.23/16	—	6	Basse & Selve	BuS.IV	1800	2	2	48	21·6	440	10,500	15,900	125	—	—	4000
SSW	R.VIII	R.24/16	—	6	Basse & Selve	BuS.IV	1800	2	2	48	21·6	440	10,500	15,900	125	—	—	4000
Staak	R.VI	R.25/16	—	4	Mercedes	D.IVa	1040	2	2	42·2	22·1	332	7,680	11,460	130	3000	55	3800
Staak	R.VI	R.26/16	—	4	Mercedes	D.IVa	1040	2	2	42·2	22·1	332	7,680	11,460	130	3000	55	3800
Staak	R.VI	R.27/16	Schül	4	Mercedes	D.IVa	1040	2	2	42·2	22·1	332	7,680	11,460	130	3000	55	3800
Staak	R.VI	R.28/16	Schül	4	Maybach	Mb.IVa	980	2	2	42·2	22·1	332	7,921	11,848	135	3000	43	4320
Staak	R.VI	R.29/16	Schül	4	Maybach	Mb.IVa	980	2	2	42·1	22·1	332	7,921	11,848	135	3000	43	4320
Staak	R.VI	R.30/16	—	4	Mercedes	D.IVa	1040	2	2	42·2	22·1	332	8,600	11,590	160	3000	35	5900
Staak	R.VI	R.31/16	—	4	Mercedes	D.IVa	1040	2	2	42·2	22·1	332	7,680	11,460	130	3000	55	3800
Staak	R.VI	R.32/16	—	4	Maybach	Mb.IVa	980	2	2	42·2	22·1	332	7,921	11,848	135	3000	43	4320
Staak	R.VI	R.33/16	Av	4	Mercedes	D.IVa	1040	2	2	42·2	22·1	332	7,680	11,460	130	3000	55	3800
Staak	R.VI	R.34/16	Av	4	Mercedes	D.IVa	1040	2	2	42·2	22·1	332	7,680	11,460	130	3000	55	3800
Staak	R.VI	R.35/16	Av	4	Mercedes	D.IVa	1040	2	2	42·2	22·1	332	9,300	12,875	130	3000	55	3800
Staak	R.VI	R.36/16	Albs	4	Mercedes	D.IVa	1040	2	2	42·2	22·1	332	7,680	11,460	130	3000	55	3800
Staak	R.VI	R.37/16	Albs	4	Maybach	Mb.IVa	980	2	2	42·2	22·1	332	7,921	11,848	135	3000	43	4320
Staak	R.VI	R.38/16	Albs	4	Mercedes	D.IVa	1040	2	2	42·2	22·1	332	7,680	11,460	130	3000	55	3800
Staak	R.VI	R.39/16	—	4	Maybach	Mb.IVa	980	2	2	42·2	22·1	332	7,921	11,848	135	3000	43	7420
Li-Ho	R.I	R.40/16	—	4	Mercedes	D.IVa	1040	2	—	33·2	15·6	265	8,000	11,200	130	3000	120	—
Li-Ho	R.I	R.41/16	—	4	Mercedes	D.IVa	1040	2	—	33·2	15·6	265	8,000	11,200	130	3000	120	—
Li-Ho	R.I	R.42/16	—	4	Mercedes	D.IVa	1040	2	—	33·2	15·6	265	8,000	11,200	130	3000	120	—
Staak	R.XIV	R.43/17	—	5	Maybach	Mb.IVa	1225	3	2	42·2	22·5	334	10,350	14,450	130	3000	70	3700
Staak	R.XIV	R.44/17	—	5	Maybach	Mb.IVa	1225	3	2	42·2	22·5	334	10,350	14,450	130	3000	70	3700
Staak	R.XIV	R.45/17	—	5	Maybach	Mb.IVa	1225	3	2	42·2	22·5	334	10,350	14,450	130	3000	70	3700
Staak	R.XV	R.46/17	—	5	Maybach	Mb.IVa	1225	3	2	42·2	22·5	334	—	—	—	—	—	—
Staak	R.XV	R.47/17	—	5	Maybach	Mb.IVa	1225	3	2	42·2	22·5	334	—	—	—	—	—	—
Staak	R.XV	R.48/17	—	5	Maybach	Mb.IVa	1225	3	2	42·2	22·5	334	—	—	—	—	—	—

ARMY AIRCRAFT (*contd.*)

Designation				Engines				Propellers		Dimensions			Weights		Performance			
Factory	Type No.	Serial No.	Licence	No.	Manufacturer	Type	Total h.p.	Tractor	Pusher	Span (metres)	Length (metres)	Area (sq. metres)	Empty (kg.)	Loaded (kg.)	Speed (k.p.h.)	Climb (metres)	Climb (minutes)	Ceiling (metres)
Staak	R.XVI	R.49/17	Av	4	2 Benz 2 Benz	Bz.IV Bz.VI	1500	2	2	42·2	22·5	340	10,400	14,650	130	—	—	3710
Staak	R.XVI	R.50/17	Av	4	2 Benz 2 Benz	Bz.IV Bz.VI	1500	2	2	42·2	22·5	340	10,400	14,650	130	—	—	3710
Staak	R.XVI	R.51/17	Av	4	2 Benz 2 Benz	Bz.IV Bz.VI	1500	2	2	42·2	22·5	340	10,400	14,650	130	—	—	3710
Staak	R.VI	R.52/17	Av	4	Maybach	Mb.IVa	980	2	2	42·2	22·1	332	7,921	11,848	135	3000	43	4320
Staak	R.VI	R.53/17	Av	4	Maybach	Mb.IVa	980	2	2	42·2	22·1	332	7,921	11,848	135	3000	43	4320
Staak	R.VI	R.54/17	Av	4	Maybach	Mb.IVa	980	2	2	42·2	22·1	332	7,921	11,848	135	3000	43	4320
Li-Ho	R.II	R.55/17	—	4	Mercedes	D.IVa	1040	1	—	42·16	20·32	320	8,000	12,000	130	3000	45	3200
Li-Ho	R.II	R.56/17	—	4	Mercedes	D.IVa	1040	1	—	42·16	20·32	320	8,000	12,000	130	3000	45	3200
Junk	R.I	R.57/17	—	4	Mercedes	D.IVa	1040	2	—	35	22·3	200	6,000	10,000	180	5000	76	5200
Junk	R.I	R.58/17	—	4	Mercedes	D.IVa	1040	2	—	35	22·3	200	6,000	10,000	180	5000	76	5200
AEG	R.I	R.59	—	4	Mercedes	D.IVa	1040	2	—	36	19·5	260	9,000	12,700	—	—	—	—
AEG	R.I	R.60	—	4	Mercedes	D.IVa	1040	2	—	36	19·5	260	9,000	12,700	—	—	—	—
AEG	R.I	R.61	—	4	Mercedes	D.IVa	1040	2	—	36	19·5	260	9,000	12,700	—	—	—	—
AEG	R.I	R.62	—	4	Mercedes	D.IVa	1040	2	—	36	19·5	260	9,000	12,700	—	—	—	—
AEG	R.I	R.63	—	4	Mercedes	D.IVa	1040	2	—	36	19·5	260	9,000	12,700	—	—	—	—
AEG	R.I	R.64	—	4	Mercedes	D.IVa	1040	2	—	36	19·5	260	9,000	12,700	—	—	—	—
Schül	R.I	R.65	—	6	Basse & Selve	BuS.IVa	1800	2	1	44	22·97	410	10,860	16,600	—	—	—	—
Schül	R.I	R.66	—	6	Basse & Selve	BuS.IVa	1800	2	1	44	22·97	410	10,860	16,600	—	—	—	—
Do	R.I	R.67	—	4	Maybach	Mb.IVa	980	—	—	—	—	—	—	—	—	—	—	—
Do	R.I	R.68	—	4	Maybach	Mb.IVa	980	—	—	—	—	—	—	—	—	—	—	—
Staak	R.XIVa	R.69/18	—	5	Maybach	Mb.IVa	1225	3	2	42·2	22·5	334	10,000	14,250	135	3000	45	4500
Staak	R.XIVa	R.70/18	—	5	Maybach	Mb.IVa	1225	3	2	42·2	22·5	334	10,000	14,250	135	3000	45	4500
Staak	R.XIVa	R.71/18	—	5	Maybach	Mb.IVa	1225	3	3	42·2	22·5	334	10,000	14,250	135	3000	45	4500
Staak	R.XIVa	R.72/18	—	5	Maybach	Mb.IVa	1225	3	2	42·2	22·5	334	10,000	14,250	135	3000	45	4500
—	—	R.73	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	R.74	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
SSW	R.VIIIa	R.75/18	—	6	Basse & Selve	BuS.IVa	1800	2	2	48	21·6	440	—	—	—	—	—	—
SSW	R.VIIIa	R.76/18	—	6	Basse & Selve	BuS.IVa	1800	2	2	48	21·6	440	—	—	—	—	—	—
SSW	R.VIIIa	R.77/18	—	6	Basse & Selve	BuS.IVa	1800	2	2	48	21·6	440	—	—	—	—	—	—
—	—	R.78	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	R.79	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	R.80	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	R.81	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	R.82	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	R.83	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Staak	R.XIVa	R.84/18	Schül	5	Maybach	Mb.IVa	1225	3	2	42·2	22·5	334	10,000	14,250	135	3000	45	4500
Staak	R.XIVa	R.85/18	Schül	5	Maybach	Mb.IVa	1225	3	2	42·2	22·5	334	10,000	14,250	135	3000	45	4500
Staak	R.XIVa	R.86/18	Schül	5	Maybach	Mb.IVa	1225	3	2	42·2	22·5	334	10,000	14,250	135	3000	45	4500
Staak	R.VIII	R.201/16	—	8	Mercedes	D.IVa	2080	—	—	55	30	—	—	—	—	—	—	—
Staak	R.VIII	R.202/16	—	8	Mercedes	D.IVa	2080	—	—	55	30	—	—	—	—	—	—	—
Staak	R.VIII	R.203/16	—	8	Mercedes	D.IVa	2080	—	—	55	30	—	—	—	—	—	—	—
SSW	R.IX	R.204/16	—	8	Basse & Selve	BuS.IVa	2400	2	2	—	—	—	—	—	—	—	—	—
AEG	R.II	R.205/16	—	8	Mercedes	D.IVa	2800	—	—	45·9	24·2	325	12,480	—	145	3000	41	—
Staak	R.IX	R.206/16	—	8	Mercedes	D.IVa	2800	—	—	55	30	—	—	—	—	—	—	—

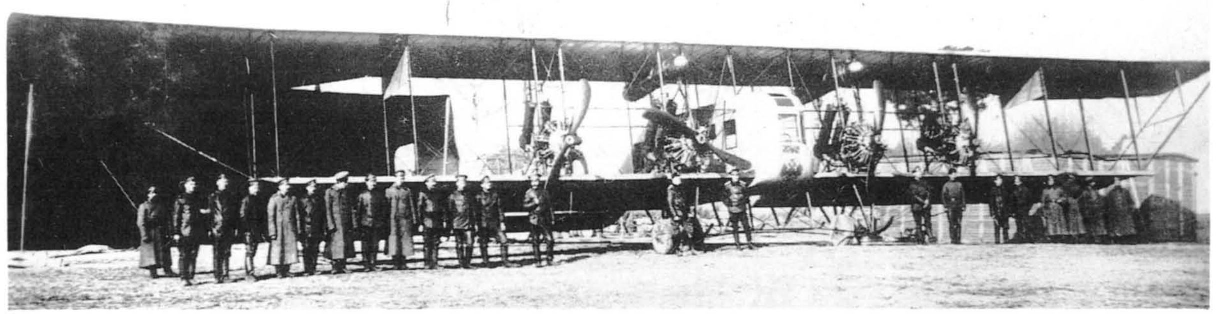
NAVAL AIRCRAFT

Designation				Engines				Propellers		Dimensions			Weights		Performance			
Factory	Type No.	Serial No.	Licence	No.	Manufacturer	Type	Total h.p.	Tractor	Pusher	Span (metres)	Length (metres)	Area (sq. metres)	Empty (kg.)	Loaded (kg.)	Speed (k.p.h.)	Climb (metres)	Climb (minutes)	Ceiling (metres)
VGO	VGO.I	RML.1	—	3	Maybach	HS	720	1	2	42·2	24	332	6,520	9,520	110	2000	39	3000
VGO	VGO.I (rebuilt)	RML.1	—	5	Maybach	Mb.IVa	1225	1	2	42·2	24	320	7,450	11,485	130	3000	60	—
Do	Rs.I	—	—	3	Maybach	HS	720	—	3	43·5	29	328·8	7,500	10,500	—	—	—	—
Do	Rs.II	—	—	3	Maybach	HS	720	—	3	33·2	23·88	257	6,475	7,323	—	—	—	—
Do	Rs.II (rebuilt)	1433	—	4	Maybach	Mb.IVa	980	2	2	33·2	23·88	234·3	7,278	9,158	128	2500	50	—
Do	Rs.III	1431	—	4	Maybach	Mb.IVa	980	2	2	37	22·75	226	7,865	10,670	135	2000	35	—
Do	Rs.IV	8801/02	—	4	Maybach	Mb.IVa	980	2	2	37	22·3	226	7,237	10,600	138	2000	53	—
Do	Rs.V(?)	8803/04	—	4	Maybach	Mb.VI (?)	2400	2	2	44	28	—	—	—	—	—	—	—
Do	Rs.V(?)	8803/04	—	8	Maybach	Mb.IVa	1960	2	2	44	30	—	—	—	—	—	—	—
AEG	—	9301	—	4	Maybach	Mb.IVa	980	—	—	—	—	—	—	—	—	—	—	—
AEG	—	9302/03	—	4	Maybach	Mb.IVa	980	—	—	—	—	—	—	—	—	—	—	—
Staak	L	1432	—	4	Mercedes	D.IVa	1040	2	2	42·2	22·2	360	8,400	11,800	125	1780	60	2500
Staak	—	8301/02	—	4	Mercedes	D.IVa	1040	2	2	42·2	21	340·5	9,000	12,500	130	3000	54	—
Staak	—	8303/06	—	4	Mercedes	D.IVa	1040	2	2	42·2	21	340·5	9,000	12,500	130	3000	54	—
Staak	—	8307	—	4	Benz	Bz.VI	2120	2	2	—	—	—	—	—	—	—	—	—
Junk	F.B. Proj.	—	—	4	Junkers	—	4000	4	—	80	38	1000	—	48,000	—	—	—	—
Zschach	F.B. Proj.	—	—	4	Mercedes	D.IVa	1040	2	—	42·7	22·8	350	—	12,000	128–140	3000	80	—

Sikorsky "Ilia Mourumetz"

The world's first four-engined aeroplane, designed by the Russian, Igor Sikorsky, had a great influence on the aeronautical community throughout the world. The early "Le Grand" and "Russkii Vitiaz" machines visibly demonstrated that it was possible to operate four engines in unison and that a large aircraft could be readily controlled in flight. As stated in the Introduction, here was the true promise of flight: a vehicle to conquer long distances at high speeds in relative safety. Because of the influence of the Sikorsky "giants", particularly the "Ilia Mourumetz" bombers, a short description of the latter is included in this book.

Developed from Igor Sikorsky's record-breaking "Le Grand" and "Russkii Vitiaz" passenger-carrying machines of 1913, the slightly larger "Ilia Mourumetz" was flown for the first time in January 1914. In the summer of that year the Russian Army placed an order for ten machines of the "Ilia Mourumetz" class.[1]



Sikorsky I.M. B (E.V.K. aircraft number VI), at Yablonna in December 1914.

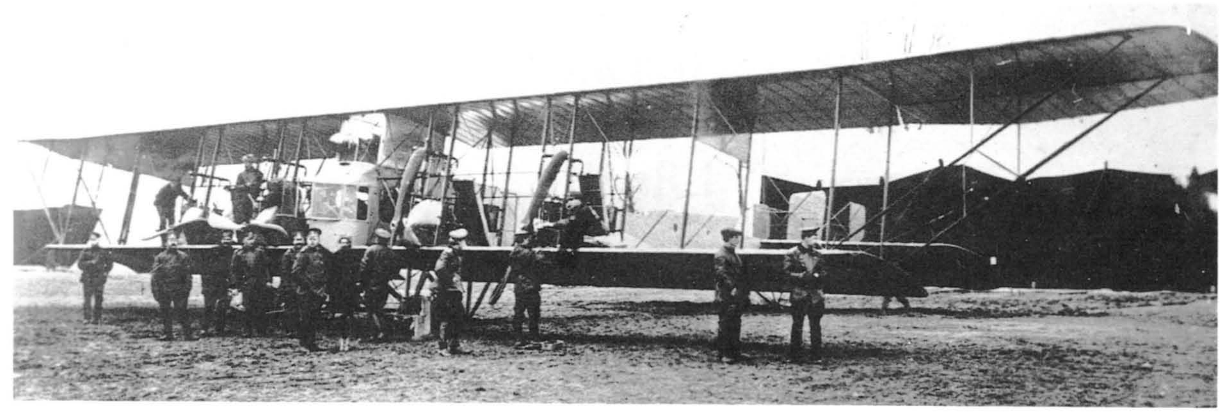
The first operational bomber (actually the second one built) was completed in the spring of 1914. On 15 February 1915 the "Kievsky", as the machine was named, took-off from Jablonna airfield to bomb German forces stationed near Plotsk. On this, its first operational mission, it carried a crew of five and bomb load of 600 kg. Nine days later it bombed the railroad station at Willenberg, returning the next day to destroy two ammunition trains detained by the previous day's attack.

As more "Ilia Mourumetz" class bombers reached active service, they were grouped into a special squadron known as the E.V.K. (Eskadra Vozdushryh Kovablei). This squadron moved from one front sector to another as required, several additional E.V.K. squadrons were formed as the number of available bombers increased. During 1916 as many as ten bombers would fly on a single mission, and an even greater number in 1917. Available records for the first sixteen operational "Ilia Mourumetz" bombers state that they flew 422 sorties between February 1914 and October 1917. A total of 2300 bombs were dropped and 7000 aerial photographs were taken during this period.

The ruggedness of these bombers must have impressed the Germans who met them in combat. The bombers were quite difficult to shoot down; one machine returned to base with 374 shrapnel and bullet holes and one wing strut shot away. Other aircraft returned safely with one or two engines out of action. The crews of the "Ilia Mourumetz" could also hit back if their claim for thirty-seven enemy aircraft shot down is correct.

Of the seventy-three "Ilia Mourumetz" class bombers constructed, about half were used at the front; the remainder were placed into service primarily as trainers. In thirty-two months of active service only four bombers were lost: two through enemy action, one spun into the ground, and one was lost as a result of Bolshevik sabotage. With the disintegration of the Russian Front at the time of the revolution many of the "Ilia Mourumetz" bombers were destroyed to prevent their capture by the Germans. It is claimed that thirty machines were burned by their own crews at the Vinnitz airfield.

[1] "Ilia Mourumetz", a legendary Russian hero, was the name given to the first machine only, but later it was used to designate the whole series and each machine was given a number, i.e., IM.IX, IM.XIV.



Sikorsky I.M. V, one of several aircraft that bore the name "Kievsky". Igor Sikorsky is seen second from the right.

The "Ilia Mourumetz" bombers had a span of about 31·1 metres (102 feet), a wing area of 158 square metres (1700 square feet) and an overall length of 20·2 metres (66 feet 3 inches). The most striking characteristic was the small amount of fuselage projecting ahead of the wings, giving the bombers a sawn-off appearance. Production was undertaken by the Russo-Baltic Wagon Works in Riga. The basic design was progressively modified; for instance, the original machine was provided with four German 120 h.p. Argus engines, but later types were fitted with British and French engines totalling 880 h.p. Similarly, wing area and weight were increased. The total weight of later types was 17,000 lb., of which 6600 lb. was useful load. The "Ilia Mourumetz" bombers were the first to have a tail-gun position, which the gunner reached by riding a trolley on rails running along the inside of the fuselage. At least one "Ilia Mourumetz" was fitted with floats for tests with the Russian Navy.

PART II

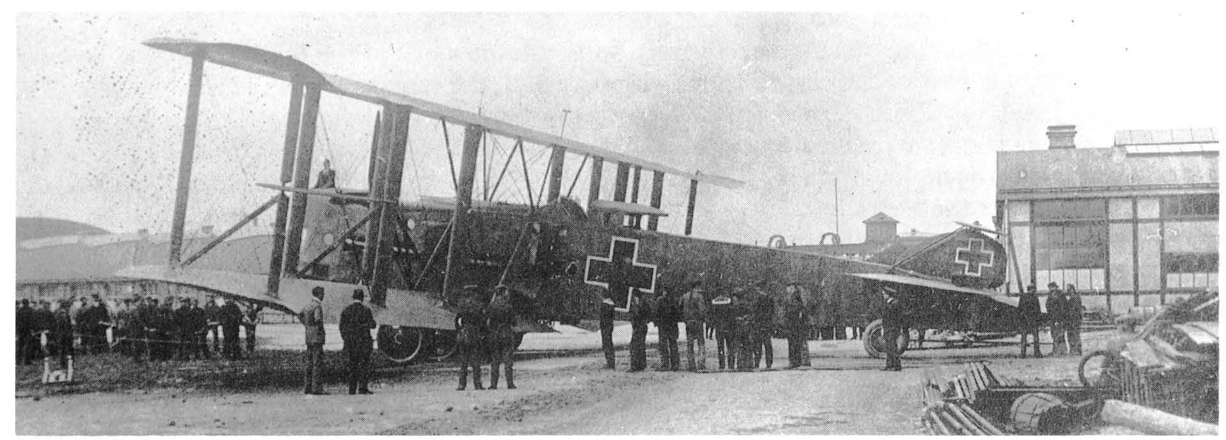
AEG R.I

By virtue of the experience gained building twin-engined bombers, the Allgemeine Elektrizitäts Gesellschaft (AEG) was included in the ambitious R-plane programme of 1916 along with SSW, Schütte-Lanz, Albatros, Aviatik and others. At the time, two giant bombers were ordered, designated R.I 21/16 and 22/16 and followed by an order for an additional six R.I machines numbered R.59 to R.64. Only one aircraft, the R.21, was flown before the end of hostilities. The R.I was born of much engineering skill and technical know-how as represented by AEG's staff of experienced engineers. Oberleutnant Brückmann, former test pilot of the DFW R.I, was in charge of the venture established by AEG on 1 January 1917. Ing. Sander, formerly with DFW and SSW, was chief engineer, and his assistants were Dipl.-Ing. Werner Zorn, who also had been with DFW, and consultant Prof. Oesterlein of the Technische Hochschule, Brunswick. Design of the R.21 began in a rented eight-room flat in Berlin. An assembly shed was erected next to the Rumpler factory in Johannisthal. In the autumn of 1917 the design bureau moved there to supervise the construction of the R.21.

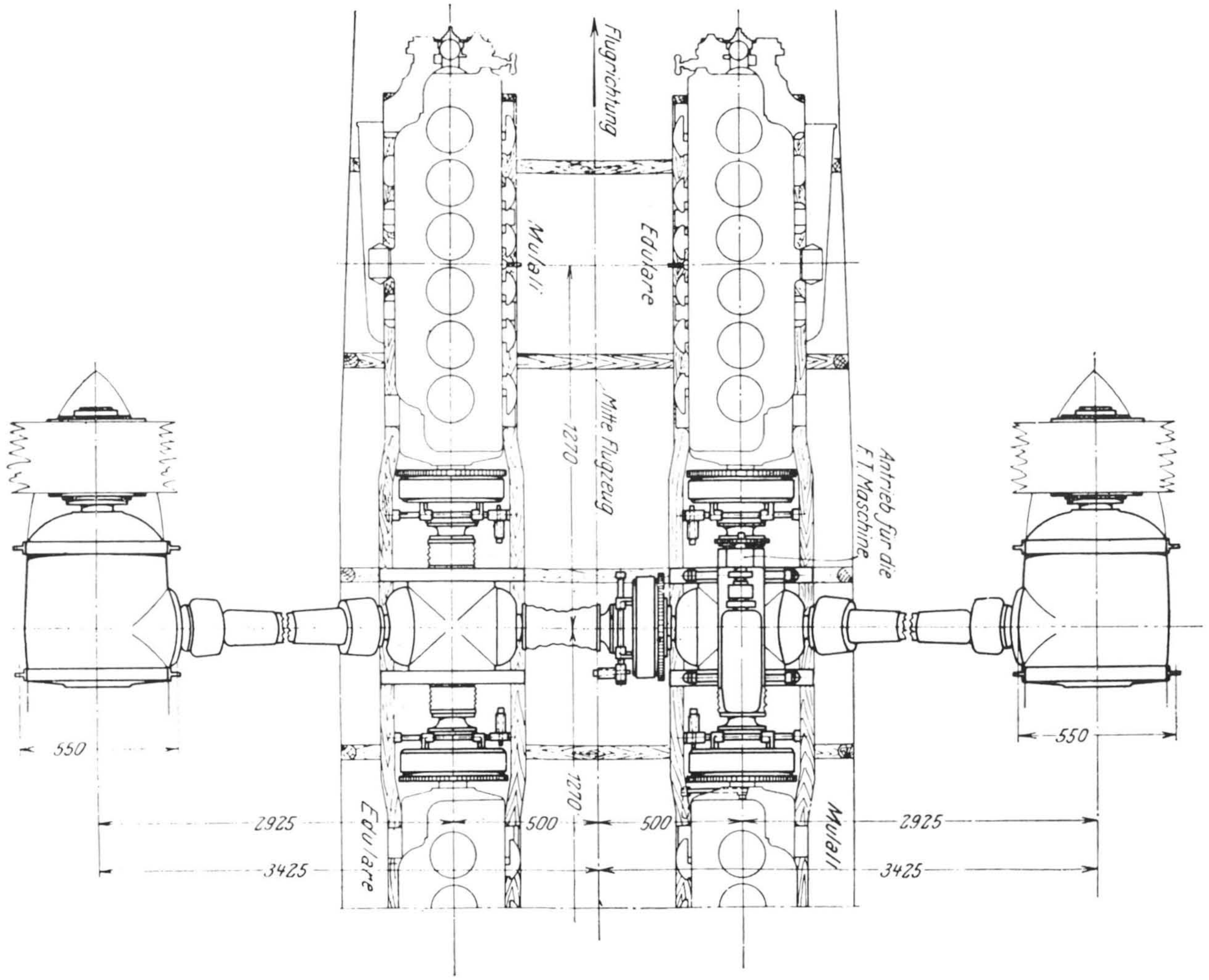
The R.I's long embryonic period from early 1917 until its first flight on 14 June 1918 reflected careful design, attention to detail and many hours of extensive bench tests. No effort was spared to incorporate lessons learned from the earlier giants, and many improvements and innovations were tried. Particularly noteworthy were the electrically-operated tailplane trim controls, the all-steel fuselage and the mixed steel and duraluminium wings. One of the most obstinate problems, which, perhaps, was never really solved, was engine misalignment and transmission vibration in centrally-powered aircraft. To mitigate this effect the R.I was literally built around a massive reinforced engine mount which supported fuselage, wings, landing gear and engines.

The four 260 h.p. Mercedes D.IVa engines were each linked to the drive system through a combination leather cone and dog clutch, while a fifth clutch connected each bank of engines. The airscrews were driven by two heavy transmission shafts running from a central gear-box to the propeller gear-box mounted between the wings. Articulated, sliding and universal joints were fitted to all connections to compensate for play and misalignment.

All four engines were started with a single Bosch inertia starter by first starting one engine and then "clutch-starting" the remainder. The exhaust gases were led into two large manifolds that were mounted in an indentation running along each side of the engine-room, permitting the exhaust system



The AEG R.I 21/16 in its original form.

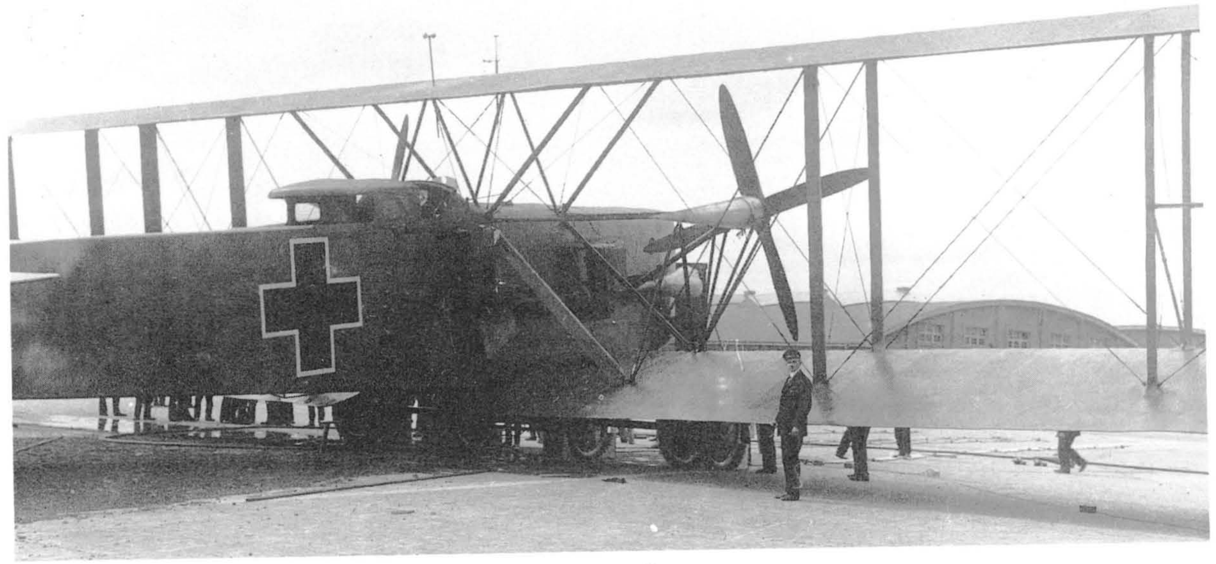


AEG R.I. Power transmission arrangement.

to operate in the airstream. Originally each engine had its own radiator bolted to the fuselage side, but later these were replaced by two large radiators composed of four separate units mounted on the centre-section struts. For a time, the AEG R.I was driven by four-bladed propellers, but these were soon replaced by two-bladed ones.

Cable-braced steel tubing was used exclusively on the frame-work of the fuselage. It was covered from the nose to the rear of the engine-room with plywood, the remainder was fabric-covered. The layout was typical of central-powered R-planes, with the exception that the pilots' cabin was situated aft of engines and wings. From this position it was considered easier for the pilot to judge his height during the critical touch-down phase, but this configuration, although tried in other R-planes, did not find favour with the crews.

The observer's cabin in the nose could be reached from the ground by a retractable ladder or through the engine-room directly aft. The cabin was fitted with glass windows to allow unobstructed vision to all sides. A spacious machine-gun post capable of holding two men was directly above the observer's cabin. The pilots' position was reached by stepping aft from the observer's cabin through a sliding door, passing through the engine-room (which was situated directly above the landing gear) between the engines on a small catwalk, and then climbing a small ladder to the cockpit. The cockpit seated two pilots and was fully-equipped with standard instruments, dual controls and the like. An engine telegraph similar in operation to those aboard ship, consisting of repeating pointers, provided



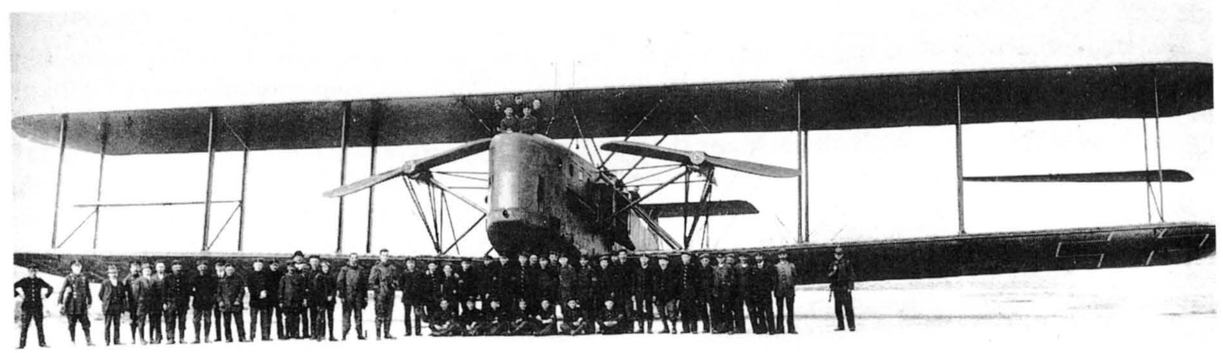
AEG R.I. 21/16. Original form fitted with four-bladed propellers.

communication between pilots and engine crew. The wireless cabin was located a few feet behind the cockpit, beneath the dorsal machine-gun post. The large windows on each side of the cabin indicated that beam machine-guns may have been considered. A ventral gun position was located in the floor.

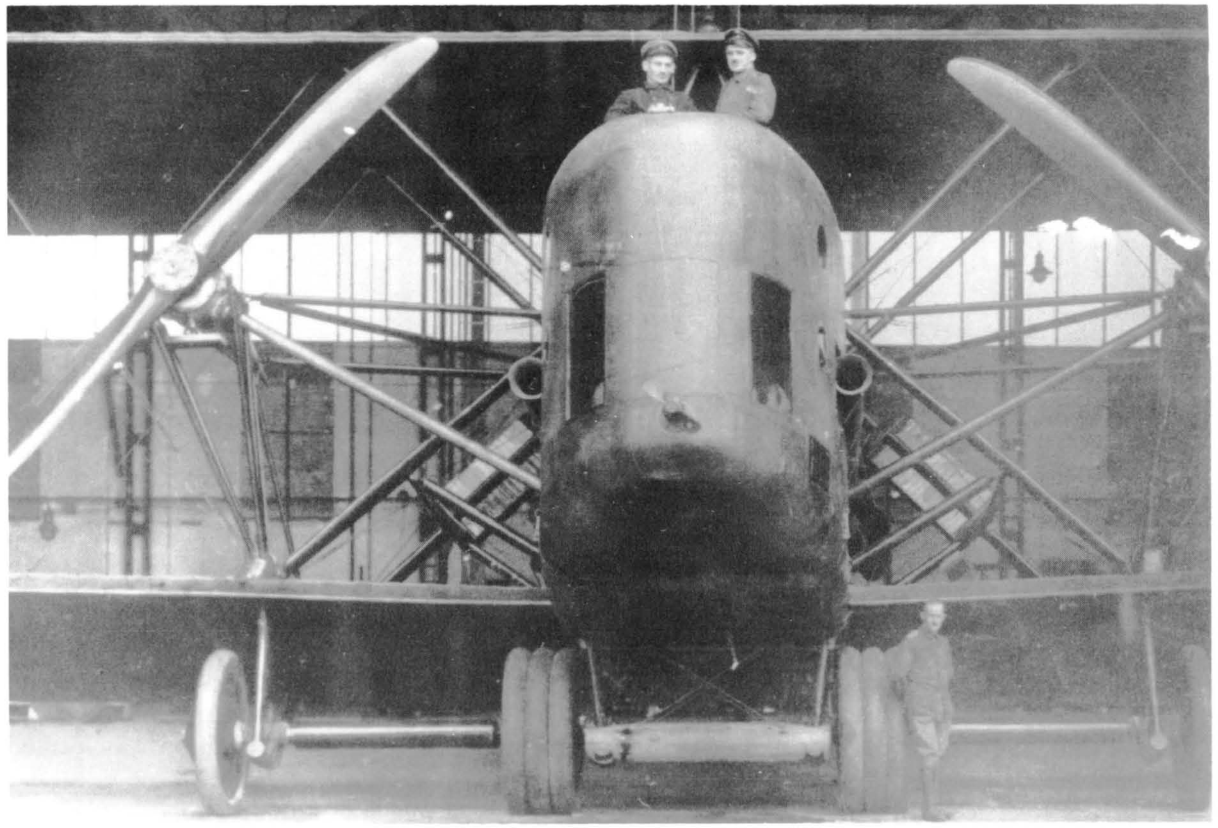
The first R.I version had a curious semi-enclosed cabin which was later modified to a simple open cockpit for better visibility, and the enclosed dorsal gun position was replaced by a standard open gun ring. After modifying the cockpit, the fuselage had its greatest dimensions at this point; a depth of approximately 10 feet and a width of 6 feet.

The wing structure consisted of two chrome-nickel steel tube spars supporting duraluminium wing ribs, cable-braced throughout. Later AEG projects were to use rectangular aluminium girder spars designed and fabricated by Zeppelin-Werke, Lindau (Dornier), pioneers in this method of construction. The three-bay biplane wing structure was of equal span and chord. A curious feature was that the angle of incidence was washed-out towards the tips, giving the wings an unusual twisted appearance. This practice was fairly common on German aircraft of the period and was supposed to improve lateral control.

The controls of the R.I were unconventional, and it is a pity that only scant information is available. The elevator, for instance, was a forerunner of the all-flying tail of supersonic jets today. It was



AEG R.I. 21/16 modified to have two-bladed propellers. Obltn. Brückmann is the tallest man in pilot's uniform beneath the left hand propeller.



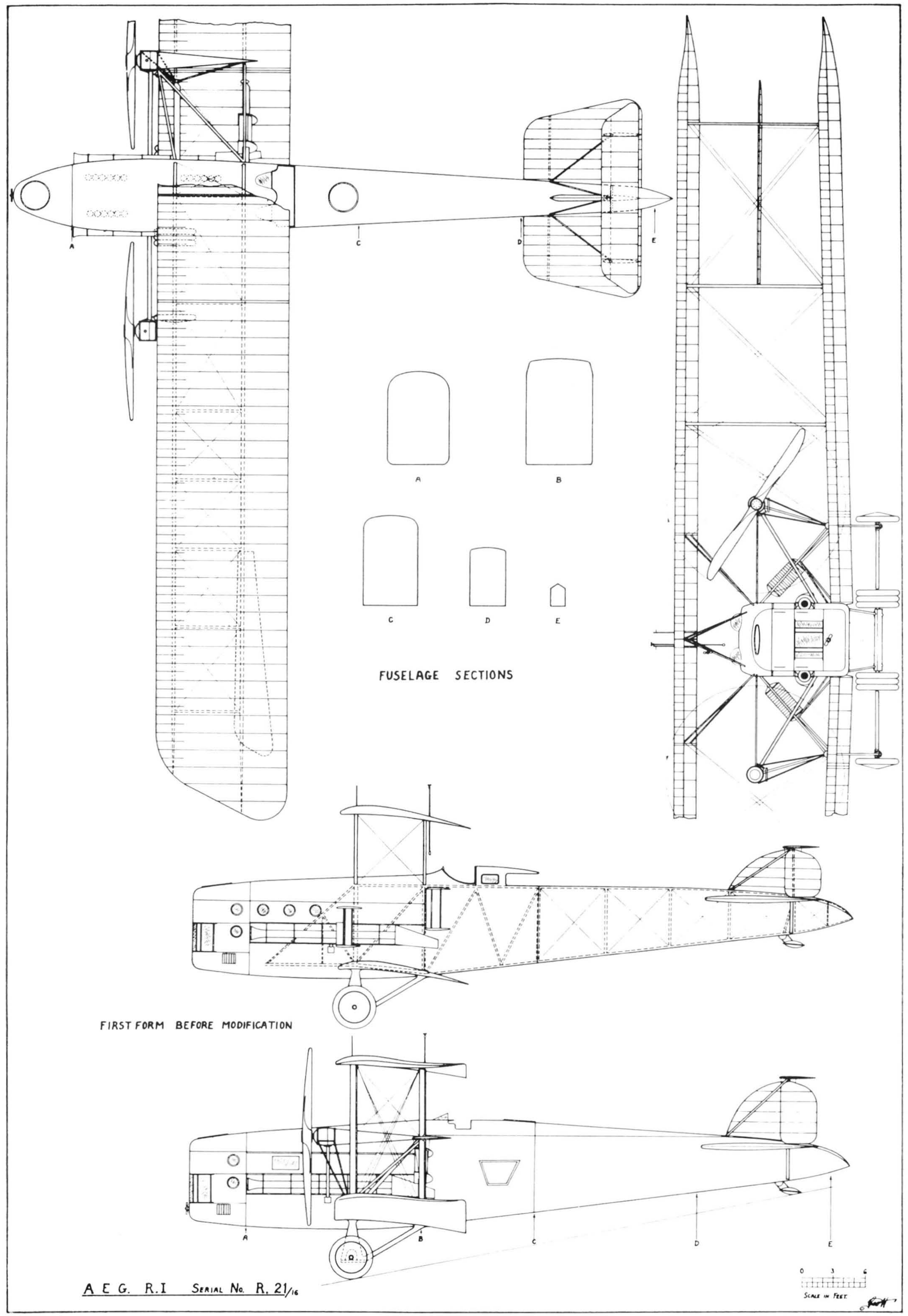
The final form of the AEG R.I with new type radiators mounted on the lower centre-section struts.

mounted some 5 feet over the tailplane, which itself could be electrically trimmed plus or minus several degrees. Two rudders were mounted between the elevator and tailplane out in the slipstream. Originally the gap between the two horizontal surfaces had been smaller, but after initial flight tests it was modified to improve control by adding more area to fin and rudders. The ailerons, rather than forming an integral part of the wing, were hinged to the outer two rear wing struts at a position midway between the wings. Like the high-set slab elevator, the aileron position was an innovation to avoid loss of control at critical angles of attack, particularly while landing.

The main landing wheels consisted of two wide-spoked hubs, each fitted with three tyres. Attached to each end of the main axle by a ball joint was an auxiliary landing gear, a kind of safety device that came into action only during a hard landing or sudden lurch that might throw the aircraft to one side.

The engines were ground tested on 23 and 30 May 1918. One engine with a broken connecting rod had to be replaced. On its first flight on 14 June 1918 the R.21, carrying a useful load of 1190 kg., flew for 27 minutes and climbed to 100 metres in a little under 10 minutes. The maiden flight was not without difficulties. With the engines throttled back the aircraft proved to be extremely tail heavy, even with full-down elevator the nose continued to rise. Only by shifting all available weight to the front was a safe landing made possible. After this initial flight the R.21 was modified as already described. It was hoped to have the work completed by 15 July 1918.

After a number of test flights it was determined that the propellers were not suitable. Additional sections were glued on at the propeller factory. Dipl.-Ing. Zorn warned Brückmann that at least ten days would be required for the glue to set, but after only four days on 3 September 1918 Brückmann ordered the propellers fitted to complete the urgent test programme. About an hour after the start a propeller flew apart, causing the cardan shaft to tear loose and shatter the centre-section structure. The R.21 broke up in the air over Rudow, killing seven men, including Brückmann, Lt. Otto

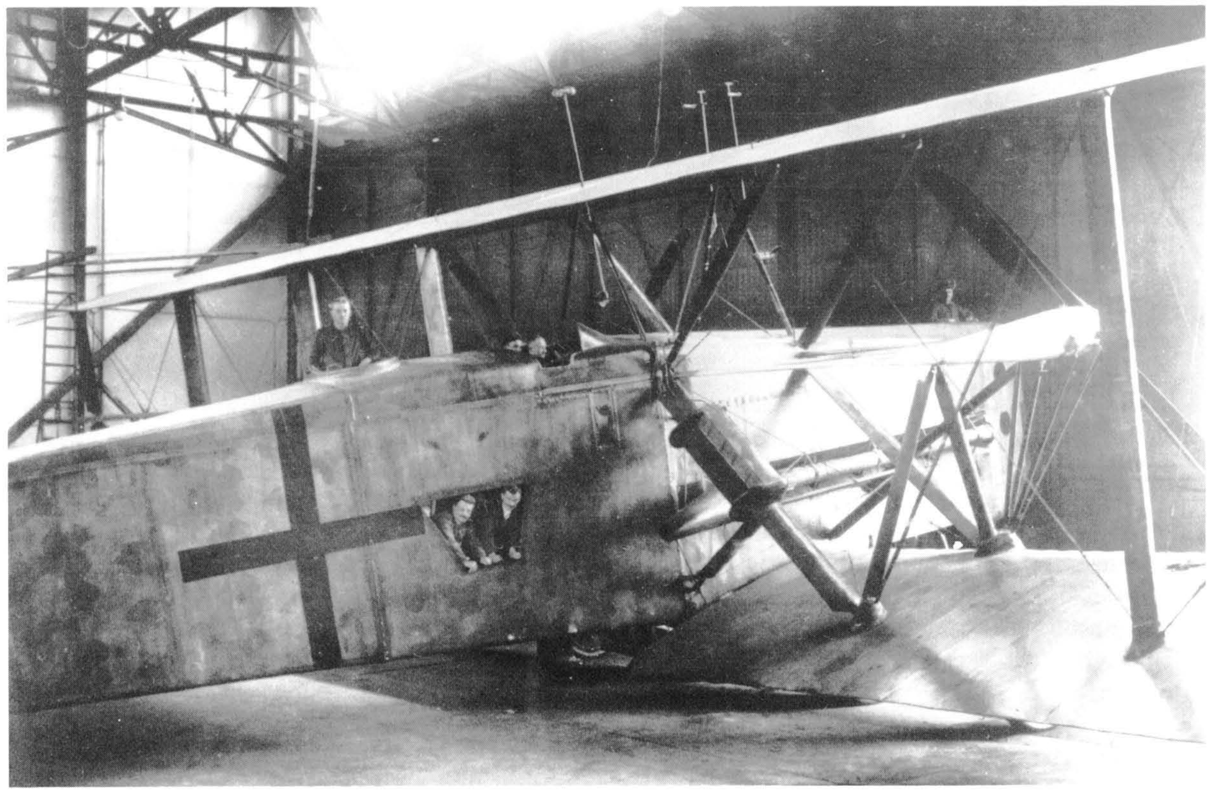


Reichardt (formerly commander of the R.13) and Lt. Dr. Oskar Wittenstein, both pre-war pilots attached to the Kommando-Riesenflugzeug-Abteilungen. Max Fiedler, who was flying escort in a Rumpler C.I, remembers the accident as follows:

> I recall being slightly over the R.21 at about 6000 feet, when Brückmann celebrating the event waved a cognac bottle as the R.21 swung into a left and then a right bank. There was a flutter and suddenly the wings folded back. It was a frightful sight.

Work on the partially completed R.22 was immediately halted until the cause of the catastrophe could be determined and fully evaluated by Idflieg.

An Idflieg document of 15 March 1918 listed these projected delivery dates for the AEG R.I aircraft: R.21 in April, R.22 and R.59 in June, R.60 in July, R.61 in September, R.62 in October



AEG R.I. 21/16. This illustration shows the redesigned dorsal crew positions of the final version.

1918. The delivery dates of the R.63 and R.64 were not listed. In spite of this optimistic schedule, only the R.21 as completed. The R.22 (which was subject of discussions between Idflieg and AEG concerning an increase in wing area as late as 5 November 1918) was partially completed at the end of the war, but not enough to prevent it from being scrapped. Only portions of the R.59 to 64 series were begun, and after the war three R.I fuselage nose sections were photographed in the AEG scrap yard.

Like SSW, AEG possessed enough resources to weather the post-war period, and it is today among the largest of German electrical concerns.

Colour Scheme and Markings

The overall finish was the standard printed camouflage pattern. The design consisted of a repeated pattern of irregular polygons of five or six dull colours, such as grey, mauve, sage green, purple,

blue and black. The actual colours and patterns varied with the sources of supply of the different aircraft manufacturers, but were all required to conform to a general standard set by Idflieg. After covering, the fabric was clear doped so that the printed pattern showed through. Latin crosses were painted on the wingtips, fuselage sides and rudders. The first version of the R.I had the early 1918 form of the Latin cross with short, broad arms, but the usual wide white outline was reduced to a thin white band. The final version of the R.I carried the standard Latin cross in use at the end of the war.

SPECIFICATIONS

Type:	AEG R.I
Manufacturer:	Allgemeine Elektrizitäts Gesellschaft, Henningsdorf near Berlin
Engines:	Four 260 h.p. Mercedes D.IVa engines
Propeller Revolutions:	750 r.p.m.
Dimensions:	Span, 36 m. (118 ft. 1½ in.)[1]
	Chord, 3·8 m. (12 ft. 6 in.)
	Gap, 4·5 to 4 m. (14 ft. 9 in. to 13 ft. 1½ in.)
	Incidence, 5 degrees
	Length, 19·5 m. (63 ft. 11½ in.)
	Height, 6·35 m. (20 ft. 10 in.)
	Tail gap, 1·5 m. (4 ft. 11 in.)
	Wheel diameter, 1·3 m. (4 ft. 3 in.)
	Propeller diameter, 5·2 m. (17 ft.)
	Propeller centres, 7·82 m. (25 ft. 8 in.)
	Propeller pitch, 3 m. (9 ft. 10 in.)
Areas:	Wings, 260 sq. m. (2798 sq. ft.)
	Ailerons, 4·4 sq. m. (47 sq. ft.)
	Tailplane, 14·0 sq. m. (151 sq. ft.)
	Elevator, 8·5 sq. m. (92 sq. ft.)
	Rudders, 2·2 sq. m. (24 sq. ft.)
Weights:	Empty, 9000 kg. (19,845 lb.)
	Useful load, 3700 kg. (8158 lb.)
	Loaded, 12,700 kg. (28,003 lb.)
Wing Loading:	49 kg./sq. m. (10·1 lb./sq. ft.)
Performance:	Not known
Fuel:	2750 litres (605 Imp. Gals.)
Armament:	Provision for five machine-guns
Service Use:	None

AEG R-plane Projects

AEG received a contract in 1916–17 to build the AEG R.II 205/16. This design fell into the same category as the Junkers and Staaken thick-wing all-metal monoplane projects intended for day-bombing use.

On 17 January 1918 the Daimler-Motoren-Gesellschaft booked an Idflieg order for a complete power system consisting of eight 260 h.p. Mercedes D.IVa engines, six double-cone couplings, two transverse transmission drives and a flywheel mounted ahead of the starter coupling. This system was intended for the AEG R.II, which, according to Daimler, had the following particulars: wing-span, 45·9 m., length 24·2 m., wing area 325 sq. m. Empty weight was estimated as 12,480 kg. (plus 530 kg. not identified). Fuel to be stored in 12 tanks and weighed 5000 kg. The tractor propellers were two-bladed with a diameter of 5·20 m.; the four-bladed pusher propellers had a diameter of 4·80 m. Estimated top speed was 145 km.h. and climb for 1000, 2000 and 3000 m. was 12, 26 and 41 minutes respectively. Duration was 12 hours for a range of 1600 kilometres. The Dornier works

[1] For convenience the metric figures are shown with their English equivalents in parentheses. It must be borne in mind that the metric measurements are the most accurate.

at Lindau had constructed several all-metal wing spars that AEG load tested for their monoplane project.

Another AEG R-plane project, mentioned in official reports in September 1918, had four 245-h.p. Maybach Mb.IVa engines and one 500 hp. Benz Bz.VI or Maybach Mb.VI driving a total of three propellers. The report stated that the project would be held in abeyance for the time being.

The AEG R.II remained on the drawing boards, as did the AEG triplane project with four 500 h.p. Mercedes engines and a wingspan of 35 metres, not to be confused with but probably similar to the AEG–Aviatik project mentioned in the next chapter.

The Navy also ordered several AEG giant aircraft in 1917 and 1918, but virtually no information exists outside of a brief mention in an official Naval document. In October 1917 an order was placed with AEG for a biplane R-seaplane with four 245 h.p. Maybach Mb.IVa engines. The number initially assigned to this type was 2139, which was later changed to 9301. Marine Baumeister Neesen recalls that this type was basically a modified R.I equipped with floats.

Two more naval R-planes were ordered in January 1918, having the numbers 9302–9303. Their configuration is not known, other than that the engines were to be four 245 h.p. Maybach Mb.IVa engines.

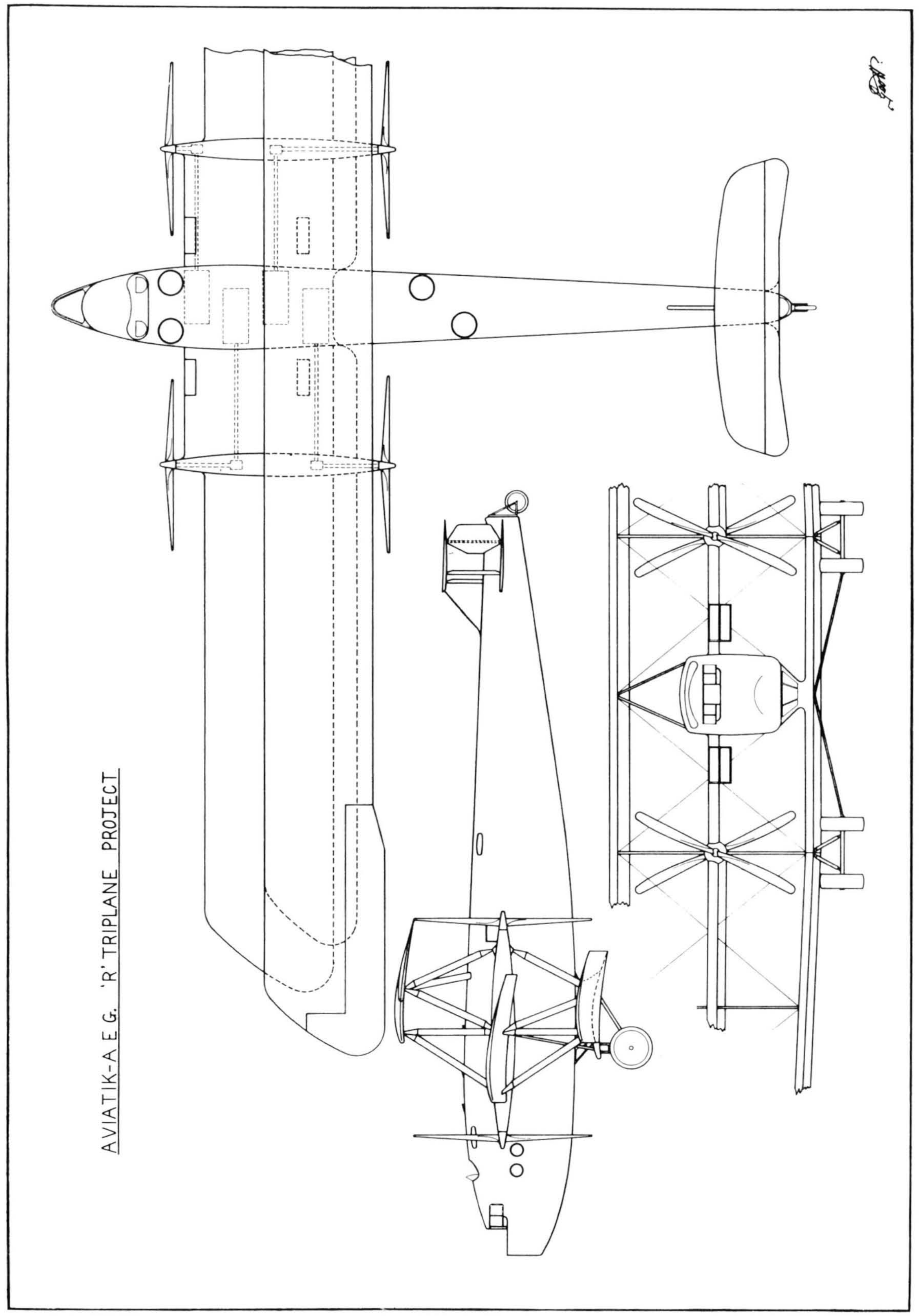
AEG–Aviatik R-plane Project

Towards the end of 1917 Idflieg, greatly influenced by the load-carrying capacity of the Caproni triplanes, fostered the construction of multi-engined triplanes, the only completed example of which was the LVG G.III. However, AEG and Aviatik undertook a joint project to build the largest R-plane envisioned at that time.

The experience of both organizations was enlisted in this ambitious project, construction of which, it is claimed, was actually started in Stettin but was halted by the Armistice. By the end of 1917 most of the test data concerning efficient triplane configurations had already been collected from wind-tunnel tests at Göttingen. During the early design stage Idflieg suggested that it might be feasible to build a 4 to 1 flying scale model to test the performance characteristics of the proposed giant. The model was to have 12–14 metre wingspan, an area of 40 square metres and a loaded weight of 1400 kg. However, the engine weight would be far in excess of the 4 to 1 scale ratio, forcing the designer, Ludwig Maurer, the Chief Engineer of Aviatik, to the conclusion that a model aircraft, in this case, would be unfeasible. Not until the advent of high power-to-weight ratio engines, would scale models become a tool to test the characteristics of larger aircraft.

The partially completed aircraft was centrally powered and presented another solution of the engine arrangement problem; in this instance the engines were mounted athwartship side by side, and each drove a single propeller by means of an extended shaft leading through the middle wing to a right-angle bevel gear-box, which eliminated the usual bulky gear and clutch systems. This and the DFW power transmission were the simplest of the central-engine systems. Although eight 250 h.p. engines were initially proposed, the advent of the 530 h.p. 12 cylinder Benz Bz.VI engine permitted the use of only four engines to attain the required 2000 horse-power. These were to be supercharged by a 120 h.p. Mercedes D.II engine driving a centrifugal compressor. Four bullet-proof and fire-resistant tanks were mounted beneath the engine bearers and had a total capacity for 8 hours' flight. The radiators were mounted on the centre wing in the slipstream of the tractor propellers.

As usual, the nose was fitted with a large machine-gun post which doubled as an open navigating position for the aircraft commander-navigator. This was followed by a fairly large closed navigation cabin, above and behind which was situated the roomy open pilots' cockpit, arranged to afford a clear view in most directions. Underneath the cockpit it was planned to have a wireless station equipped with wireless receiver, sender, sound amplifier and a dynamo which would also serve to provide illumination for night flying. Commands would be transmitted throughout the aircraft by



a machine telegraph system and pneumatic tubes. A walkway made it possible to step from the wireless station into the engine-room through a large sound-proofed bulkhead and walk to the rear of the aircraft.

The fuselage was to be constructed of four massive wooden box longerons with steel-tube cross struts and engine bearers. The wing structure was heavily staggered, reminiscent of the experimental Nieuport triplanes and shown to be an efficient arrangement by the Göttingen wind-tunnel tests. The lower wing was attached to the fuselage by a streamlined extension containing the bombardier's cabin. The aircraft was studded with machine-gun posts: one in the nose, two immediately behind the cockpit (one wonders how the pilots would have liked this); two behind the wings; one in the extreme tail, and perhaps several on the underside of the fuselage. Each crew member was to be provided with a parachute stowed near his post so that it would be instantly accessible.

The landing gear used steel springs as shock absorbers and the wheels were possibly of the steel-band type developed by Linke-Hofmann. The tail skid consisted of a sprung-wheel carriage which could be steered.

Although the AEG–Aviatik R-plane project was described in detail by the German post-war aviation press, nothing was said about its degree of completion, other than that it was "partially completed". It is very doubtful, however, if the project advanced materially beyond the barest preliminaries. The AEG–Aviatik R-plane belonged to the third generation of giant bombers in the same category as the massive Staaken R.VIII and R.IX, AEG R.II and DFW R.III.

SPECIFICATIONS

Type:	AEG–Aviatik R-Plane Project
Manufacturer:	AEG–Aviatik joint venture, Stettin
Engines:	Four 530 h.p. Benz Bz.VI engines
Dimensions:	Span, 55 m. (180 ft. 5 in.)
	Length, 27 m. (88 ft. 7 in.)
	Height, 8·8 m. (28 ft. 10 in.)
	Propeller diameter, 6 m. (19 ft. 8 in.)
Areas:	Wings, 620 sq. m. (6671 sq. ft.)
Weights (Est.):	Empty, 15,000 kg. (33,075 lb.)
	Useful load, 7000 kg. (15,435 lb.)
	Loaded, 22,000 kg. (48,510 lb.)
Performance (Est.):	Maximum speed, 145–150 km.h. (90·1–93·2 m.p.h.) at 3000 m. (9843 ft.)
	Ceiling, 5000 m. (16,405 ft.) in 120 mins.
	Duration, 8 hrs.
Armament:	Provision for six or seven machine-guns

Ago R-plane Project

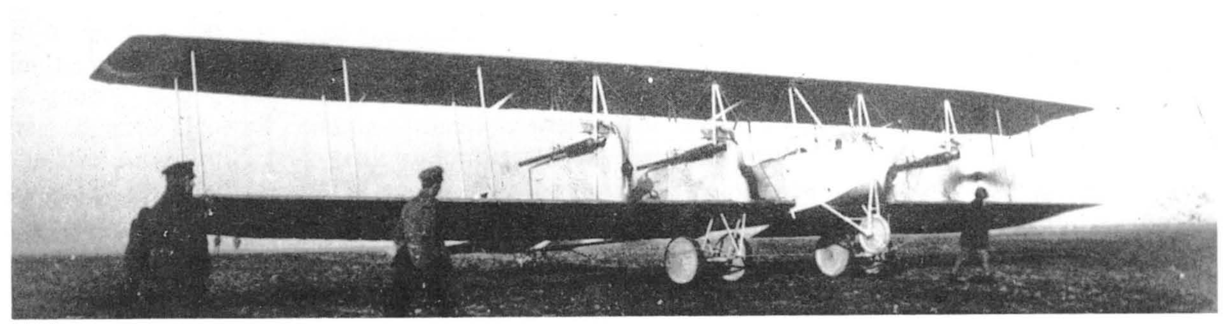
The "Rapport Technique", more commonly known as the "Inter-Allied Report", was the official publication of the Inter-Allied Aeronautical Control Commission, which was responsible for the control of aeronautical activities in Germany after the war. The "Inter-Allied Report" does contain numerous errors; yet surprisingly many of its "errors" have been proven correct by subsequent research into German wartime activities. The report does contain reference to an R-plane designed by Ago-Flugzeugwerke G.m.b.H. during the war.

Ago was awarded a war patent (No. 310,096) on 30 September 1919 which describes an aircraft with three centrally mounted engines coupled to a common gear-box, which in turn drove four propellers spaced along the trailing edge of the wing. In April 1918, Ago ordered a test assembly from Daimler-Motoren-Gesellschaft comprising three 160 h.p. Mercedes D.IIIav engines and suitable clutches connected to a right angle gear-box having two propeller drive shafts. It was planned to bench test this arrangement prior to using larger 500 h.p. engines. From available records, it seems

Ago was considering a 3000 h.p. R-plane driven by four propellers. This project was in the preliminary design stage when the war ended.

Albatros G.I

The Ostdeutsche Albatroswerke G.m.b.H.[1] was founded on 27 April 1914 in Schneidemühl by Otto Wiener and Dr. Walter Huth, the latter also the founder of the original Albatros concern in Johannisthal. Although OAW maintained close ties with Albatros, it remained an independent company until October 1917, when it became a branch of the Albatros concern. OAW concerned



The Albatros G.I, experimental four-engined bomber built in 1915.

itself almost totally with the construction of licence-built aircraft (exclusively Albatros types), but did produce a few aircraft of its own design. Among these was a four-engined bomber known as the Albatros G.I (company designation L4), which was designed by an engineer named Grohmann, who was appreciably influenced by the Sikorsky four-engined bomber. The G.I fell into the same grouping as the Union, SSW-Forssman and Daimler bombers; that is, they were early aircraft of considerable size, but their engine configuration did not permit in-flight servicing. Four 120 h.p. Mercedes D.II engines powered the G.I, which had a wingspan of 27 metres. These were mounted on the lower wing in large full-enclosed nacelles and drove four tractor propellers. The Swiss pilot Alexander Hipleh flew the G.I on its maiden flight on 31 January 1916. The G.I was subsequently developed into the Albatros G.II and G.III, which bore a certain family resemblance to the G.I although they were twin-engined bombers. Further details concerning the G.I are not known.

In early 1917 OAW received a contract to build three Staaken R.VI bombers under licence. The first of the series, numbered R.36 to R.38, was begun in May 1917 and the last machine was delivered in May 1918. The Staaken R.VI chapter contains additional information concerning these machines.

SPECIFICATIONS

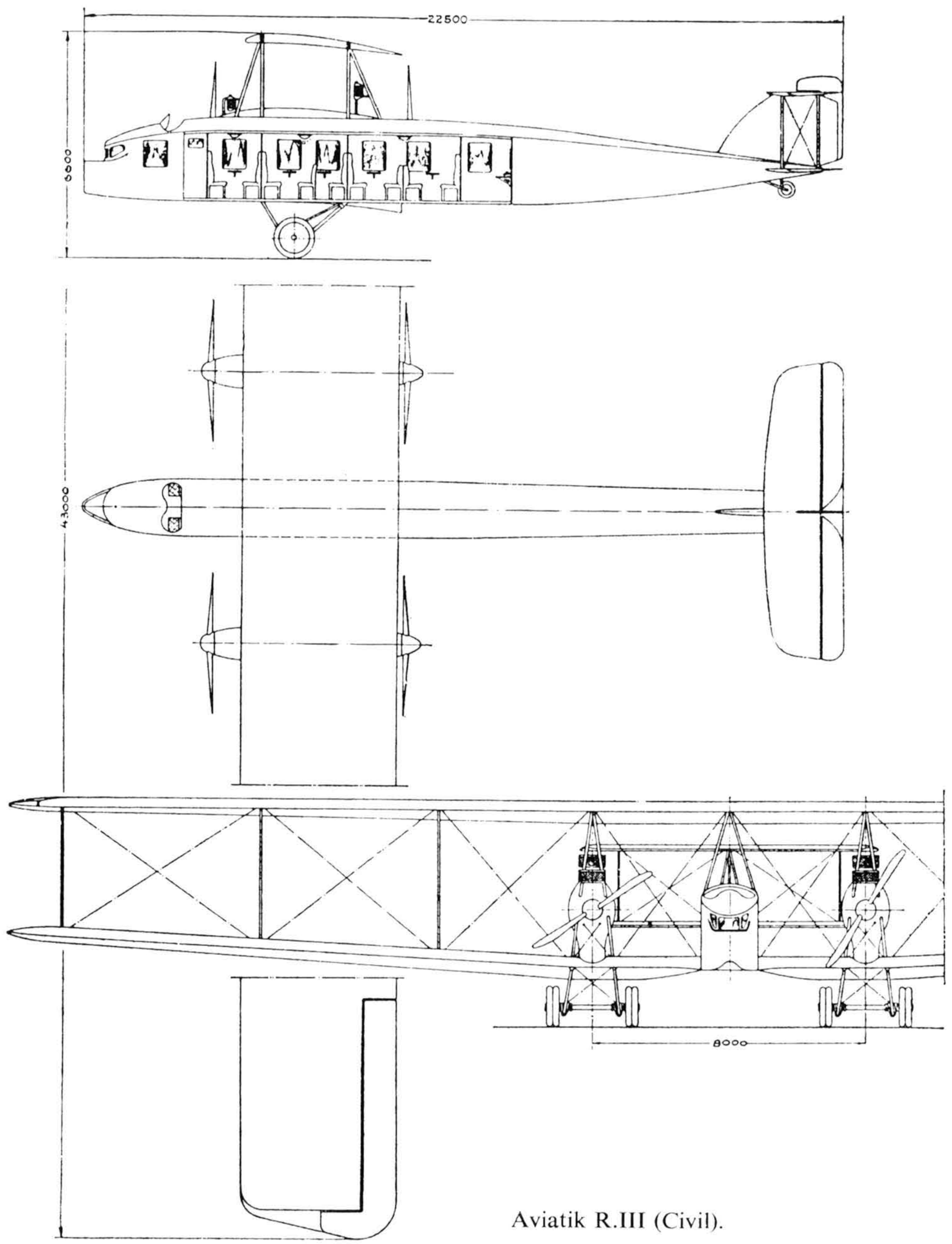
Type:	Albatros G.I
Manufacturer:	Ostdeutsche Albatroswerke G.m.b.H., Schneidemühl
Engines:	Four 120 h.p. Mercedes D.II engines
Dimensions:	Span 27·3 m. (89 ft. 6½ in.)
	Chord 2·75 m. (9 ft. ½ in.)
	Fuselage Length 12·0 m. (39 ft. 4¼ in.)
Areas:	Wing 138 sq. m. (1485 sq. ft.)
	Ailerons 3·03 sq. m. (33 sq. ft.)
	Tailplane 6·6 sq. m. (71 sq. ft.)
	Rudder 1·5 sq. m. (16 sq. ft.)
	Fin 1·92 sq. m. (20 sq. ft.)

[1] The company abbreviation initially was "Albs" and the correct designation of the licence-built R-planes was Staaken R.VI (Albs) 36/16. Later in the war the company abbreviation was changed to "OAW", as in Albatros D.Va (OAW).

Weights:	Empty 3452 kg. (7610 lb.)
	Loaded 4319 kg. (9522 lb.)
Wing Loading:	31·3 kg./sq. m. (6·4 lb./sq. ft.)
Performance:	Climb, 2000 m. (6562 ft.) in 60 mins.

Aviatik R.III Civil Project

The name Aviatik had already achieved considerable fame as the trade-mark of the Automobil und Aviatik A.G. in Leipzig-Heiterblick, a manufacturer of a line of successful pre-war aircraft. During the war, Aviatik mass produced trainer and observation biplanes, a handful of fighters and Gotha G.VII bombers under licence.



Aviatik R.III (Civil).

The firm also made a large contribution to the R-plane programme as the most important licence manufacturer of Staaken R-planes. The initial order was for three Staaken R.VI machines numbered R.33/16 to R.35/16, the first of which was delivered in September 1917. Unofficially this series was known as the Aviatik R.I in company literature disseminated by Aviatik after the war. There is neither record nor reason to substantiate that the R.I designation was ever officially sanctioned. The first series was followed by a second batch of three Staaken R.VI machines numbered R.52/17 to R.54/17. These aircraft (known internally as Aviatik R.II) were modified to some extent by Aviatik, and in at least one instance the stepped, glassed-in cockpit was eliminated and replaced by a front-gun position and open cockpit raised flush with the upper longerons. The first aircraft (R.52) was initially powered by four 300 h.p. Basse & Selve BuS.IVa engines. These gave trouble during ground tests conducted on 7 May 1918, and were replaced by the more reliable, but less powerful, 245 h.p. Maybach Mb.IVa engines. The acceptance flight took place on 5 June, and Idflieg promised official acceptance on 28 June, provided that various defects were remedied. However, such was the demand for aircraft that the R.52 left for Rfa 500 at Morville on 20 June, stopping *en route* at Hannover due to poor weather conditions. The second machine, R.53, was delivered in July 1918, and was assigned to Rea Cologne as a trainer. The completion of the last Aviatik-built Staaken R.VI was delayed until October pending a decision whether or not to install a fifth Maybach in the nose. The final series built by Aviatik under licence was the Staaken R.XVI, R.49/17 to R.51/17 (known internally as Aviatik R.III), of which only the R.49 was delivered prior to the war's close.

In early 1919 Aviatik had the three-quarters completed R.50 and R.51 on its hands, and it received permission to complete these as commercial transports, but only the R.50 was finished (see Staaken R.XVI chapter).

In hopes of entering the commercial passenger and air-mail aircraft business, Aviatik publicized the Aviatik R.III Civil Transport. The R.III received full coverage in the aeronautical Press, and beautifully retouched photographs gave the impression that the machine was actually built. However, the civil adaptation did not advance farther than the design stage. The fuselage was redesigned to accommodate eighteen passengers in seats placed back-to-back. A small open cupola was situated in the nose, followed by an enclosed observation cabin. The pilots were located in an open cockpit well ahead of the wings. The four tandem, geared 250 h.p. Benz engines were mounted on streamlined pylons above the lower wing. These pylons carried enough fuel for 7 hours maximum duration, and the engines were serviceable in flight. The wing area was increased by keeping the chord constant throughout the span. The crew consisted of an aircraft captain, two pilots, two engineers and a steward.

Engineers von Platen and Rau, both of whom had earlier been closely associated with the SSW R-plane programme (Rau as a member of Idflieg), later joined Aviatik to work on licence machines and advanced projects such as the R.III.

SPECIFICATIONS

Type:	Aviatik R.III (Civil Project)
Manufacturer:	Automobil & Aviatik A.G., Leipzig–Heiterblick
Engines:	Four 250 h.p. Benz engines
Dimensions:	Span, 43·5 m. (142 ft. 9 in.)
	Length, 22·5 m. (73 ft. 10 in.)
	Height, 6·5 m. (21 ft. 3½ in.)
Weights (Est.):	Empty, 9000 kg. (19,845 lb.)
	Fuel and crew, 1800 kg. (3969 lb.)
	Disposable load, 1800 kg. (3969 lb.)
	Loaded, 12,600 kg. (27,783 lb.)
Performance (Est.):	Maximum speed, 125 km.h. (78 m.p.h.) at 2500 m. (8200 ft.)
	Climb, 3500 m. (11,483 ft.) in 100 mins.
	Ceiling, 4000 m. (13,124 ft.)
	Duration (max.), 7 hrs.
	Range, 875 km. (544 miles)

Daimler R.I and R.II

In the summer of 1915 the Daimler-Motoren-Gesellschaft A.G., manufacturers of the famous Mercedes engine, formed an aircraft construction division with hangars located at the airfield in Sindelfingen. In August they began construction of a four-engined bomber that was almost identical to the Union G.I. Daimler, having made the decision to begin aircraft production, had chosen the Union-design as its first product.

The Daimler R.I, as the Union-design was now called, was constructed under the direction of Baurat Rittberger and Ing. Karl Schopper (both formerly with Union) at the rather primitive and make-shift facilities at Sindelfingen. Most of the R.I and R.II parts were built by the Stuttgart firm of Schiedmayer and taken to Sindelfingen for assembly. The R.I fuselage was more robust than its predecessors, and the troublesome inverted engines were replaced by the reliable 160 h.p. Mercedes D.III engines. The R.I first flew in late 1915 at Sindelfingen. While engine problems had been eliminated, the airframe had to be strengthened more than once. At least three different wing assemblies were flight-tested between 1915 and 1917. A second R.I was constructed with a larger tail to improve directional control.

Daimler R.II

Idflieg was interested in the R.I, initially as an experimental type, later as a trainer for G-type bomber crews. Although the performance and flight characteristics of the Daimler R.I were not very promising, the aircraft were test flown until the middle of 1917. In November 1917 one G.I (as the R.I was now designated) was transferred to Idflieg.

Two examples of an improved version, the Daimler R.II, were constructed in the spring of 1916.[1] Outwardly more robust in appearance, the R.II was almost an exact duplicate of the R.I. The overall dimensions were similar, only the weight was slightly increased. A major change was the finely shaped nacelles, mounted between the wings and supported in the centre by a streamlined pylon. Both R.II bombers were taken over by Idflieg and remained on flight status until the middle of 1917 at Sindelfingen.

In 1916 the R.I and R.II were redesignated G.I and G.II, since they belonged to the same category as the four-engined Union G.I Albatros G.I and SSW-Forssman R-types: large in size, but engines not serviceable in flight. Records in the Daimler-Benz archives show that the R.I (G.I) and two R.II (G.II) bombers were numbered 478/15, 450/15 and 451/15 respectively. These numbers do not fit the R-plane numbering sequence, or the 1915 G-type sequence.

[1] According to the Sindelfingen city archive and latest researches at the Daimler-Benz Archiv, a total of six R.II aircraft were built. Two were taken by Idflieg and four were crated in boxes for reasons unknown.

SPECIFICATIONS

Type:	Daimler R.I
Manufacturer:	Daimler-Motoren-Gesellschaft A.G., Sindelfingen
Engines:	Four 160 h.p. Mercedes D.III engines
Dimensions:	Span, 21·08 m. (69 ft. 2 in.)
	Length, 18·35 m. (60 ft. 2¼ in.)
	Height, 3·80 m. (12 ft. 6 in.)
Areas:	Wings, 73·62 sq. m. (792 sq. ft.)
Weights:	Empty, 2512 kg. (5538 lb.)
	Loaded, 3630 kg. (8003 lb.)
Wing Loading:	49·3 kg./sq. m. (10·1 lb./sq. ft.)
Performance,	Maximum Speed, 120 km.h. (74·6 m.p.h.)
	Cruising Speed, 114 km.h. (70·8 m.p.h.)
	Climb, 1000 m. (3281 ft.) in 16·8 mins.
	1500 m. (4921 ft.) in 26·9 mins.
	Ceiling, 3000 m. (9843 ft.)

SPECIFICATIONS

Type:	Daimler R.I (second version)
Manufacturer:	Daimler-Motoren-Gesellschaft A.G., Sindelfingen
Engines:	Four 160 h.p. Mercedes D.III engines
Dimensions:	Span, 21·15 m. (69 ft. 4 in.)
	Length, 18·20 m. (59 ft. 8½ in.)
	Height, 3·75 m. (12 ft. 3½ in.)
Areas:	Wings, 70·60 sq. m. (760 sq. ft.)
Weights:	Empty, 2510 kg. (5534 lb.)
	Loaded, 3700 kg. (8157 lb.)
Wing Loading:	52·4 kg./sq. m. (10·7 lb./sq. ft.)
Performance:	Maximum Speed, 119 km.h. (73·9 m.p.h.)
	Cruising Speed, 114 km.h. (70·8 m.p.h.)
	Climb, 1000 m. (3281 ft.) in 17·0 mins.
	1500 m. (4921 ft.) in 28·0 mins.
	Ceiling, 3000 m. (9843 ft.)

SPECIFICATIONS

Type:	Daimler R.II
Manufacturer:	Daimler-Motoren-Gesellschaft A.G., Sindelfingen
Engines:	Four 160 h.p. Mercedes D.III engines
Dimensions:	Span, 21·26 m. (69 ft. 9 in.)
	Length, 18·40 m. (60 ft. 4 in.)
	Height, 3·80 m. (12 ft. 6 in.)
Areas:	Wings, 74·80 sq. m. (805 sq. ft.)
Weights:	Empty, 2540 kg. (5600 lb.)
	Loaded, 3680 kg. (8113 lb.)
Wing Loading:	49·3 kg./sq. m. (10·1 lb./sq. ft.)
Performance:	Maximum Speed, 123 km.h. (76·4 m.p.h.)
	Cruising Speed, 120 km.h. (74·6 m.p.h.)
	Climb, 1000 m. (3281 ft.) in 15·2 mins.
	1500 m. (4921 ft.) in 25·0 mins.
	Ceiling, 3000 m. (9843 ft.)

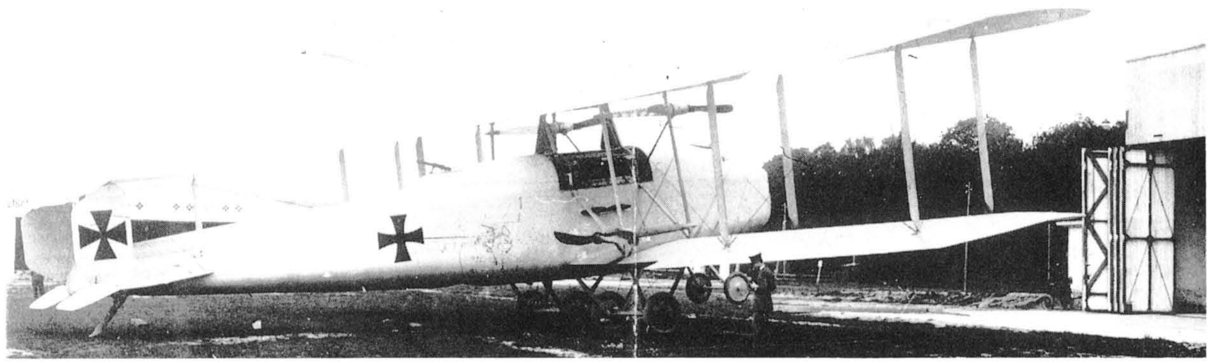
DFW R.I

The Deutsche Flugzeugwerke was founded in 1911 at Lindenthal near Leipzig, and prior to the war produced many successful aircraft, such as the "Mars" biplane and the "Stahl-Taube". One of the former was purchased by the Royal Naval Air Service in 1914. During the war DFW was a chief

supplier of C-type aircraft to the German Army Air Service, in particular, the sturdy DFW C.V.

In 1915, at the request of Idflieg, DFW joined the R-plane programme, and its contribution was a series of clean, carefully engineered aircraft noted primarily for the successful application of a simple and straightforward solution for transmitting power from internally-mounted engines to propellers.

The DFW R.I was designed by Hermann Dorner (who in October 1916 left DFW to take the position of chief engineer at the Hannoversche Waggonfabrik, where he built the well-known Hannover two-seat fighters). Heinrich Oelerich, a renowned pre-war pilot, assisted Dorner in the design of the DFW R-planes and as technical director, he was responsible for supervising the development of the R.II series. Help was also given by Prof. H. Reissner as consultant, Dipl.-Ing. Sander was the lead engineer and Oblt. Brückmann, Denicke and Steinbeck were the test



The DFW R.I 11/15 in its original form without supplementary wing-tip struts, and fitted with triangular radiators.

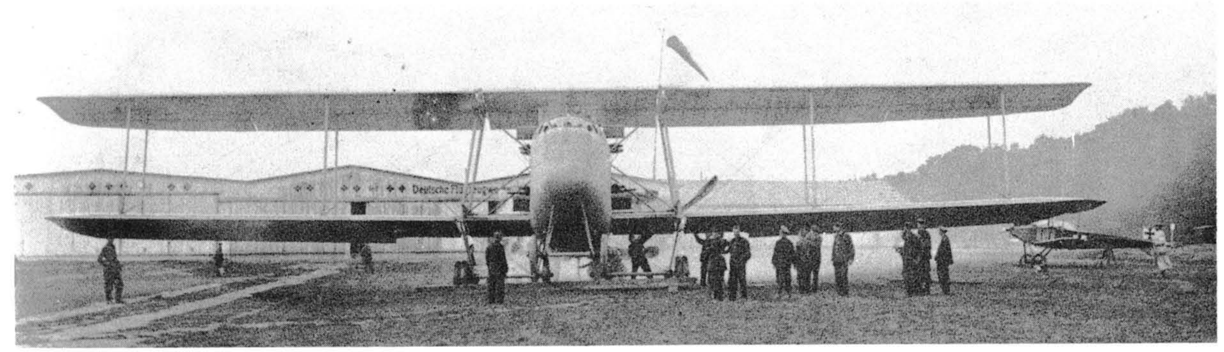
pilots. The construction of the DFW R.I 11/15 (company designation T 26) began on 1 September 1915, and was completed about a year later. The comparatively long construction period was due to a number of factors. DFW was specifically asked by Idflieg to utilize plywood for the fuselage covering, and application of this material to large curved surfaces was obviously a time-consuming process.

Furthermore, the DFW R.I and its successors were carefully engineered and showed signs of craftsmanship throughout. Finally, the effort expanded in starting production of the promising DFW C.V. observation aircraft to replace ageing Albatros, Rumpler and AEG C-types probably sapped much of the labour and materials from the R.I programme.

The R.I and later DFW giants were unique in that they were the only aircraft which had internally-mounted engines each driving a separate propeller. The four 220 h.p. Mercedes D.IV engines were arranged in the following manner: the forward pair of engines was mounted above and slightly ahead of the rear engines. Each forward engine was connected to a transmission shaft which ran at an angle from the fuselage to a streamlined right-angle propeller gear-box that was attached to the inner struts just below the upper wing. Similarly, the rear engines each drove a pusher propeller mounted near the trailing edge of the lower wing.

Each engine was equipped with a gear-box and clutch. The assembly formed four self-contained units completely independent of each other. The advantage of this system was that it eliminated the massive and complicated clutch-gear assemblies necessary to transfer power of three or four engines to a common drive shaft, and yet it retained all the desirable features of enclosed engines. This system proved to be efficient and mechanically sound in the long run, although it was many months before all the "bugs" were completely eliminated.

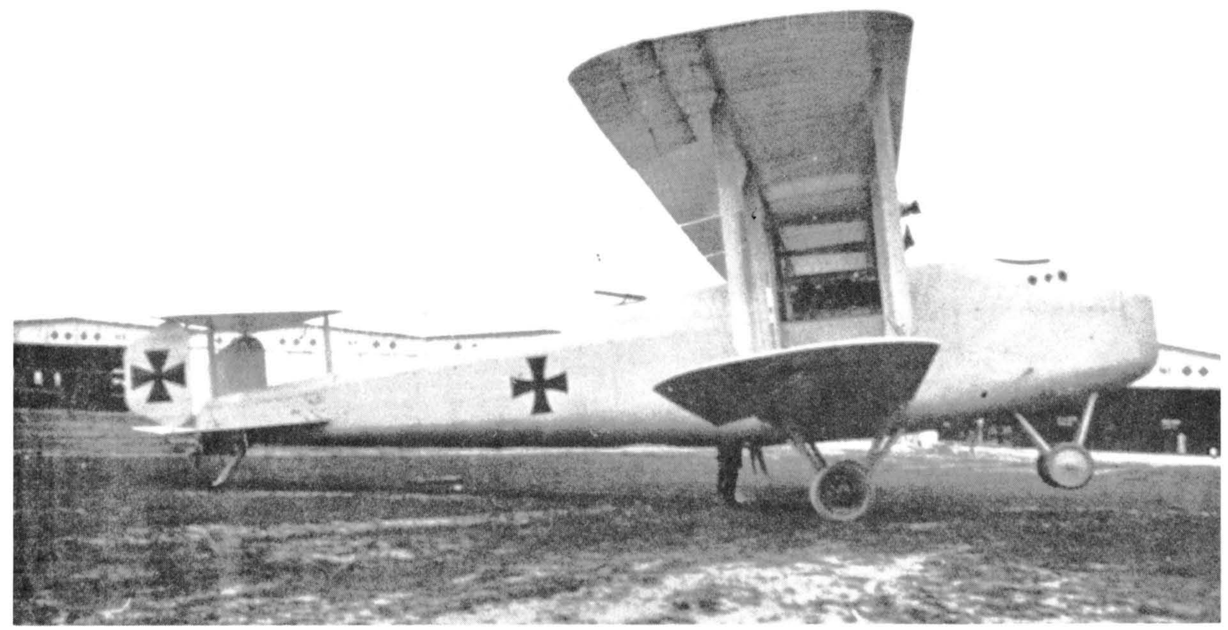
The engines were cooled initially by triangular radiators fitted between the centre-section struts. These were soon replaced by four Windhoff radiators positioned around the fuselage in the centre section gap. They were of standard pattern, very similar to those used on DFW C-types and fitted with shutters.



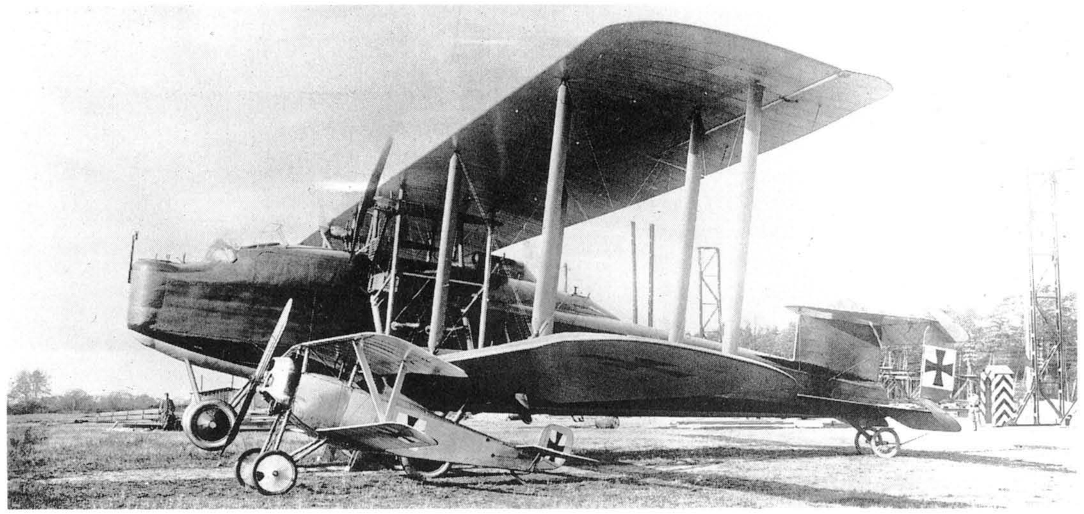
DFW R. I 11/15, with Windhoff radiators mounted on the fuselage sides.

The construction of the R.I differed only in detail from that of the larger and better known R.II. The three-bay wooden wings were fabric covered, of equal chord throughout and had washed-out wing tips. Unbalanced ailerons were fitted to the upper wings only. The centre fuselage decking of the R.I had a markedly humped appearance because the rear decking was cut down to provide a better field of fire to the rear. A noticeable feature of both the R.I and R.II was the large semi-external gravity tank located just forward of the dorsal-gun position. Initially the biplane tail did not have a central fin, but one was added at a later date. The tailplanes differed from those on the R.II in that they were triangular in form.

The R.I made its maiden flight on 5 September 1916, and after twelve factory flights (of 8 hours total duration) it was delivered from Grosszschocher to the Army air park at Döberitz, where on 19 October 1916 it successfully completed a $2\frac{1}{2}$ hour military acceptance flight. During further trials at Döberitz a number of crankshaft failures occurred, more than could be properly attributed to faulty construction or poor materials of the engine. There is no doubt that the excessively long crank-



DFW R.I 11/15. This photograph shows the first form of the tail unit with no fixed vertical surfaces.



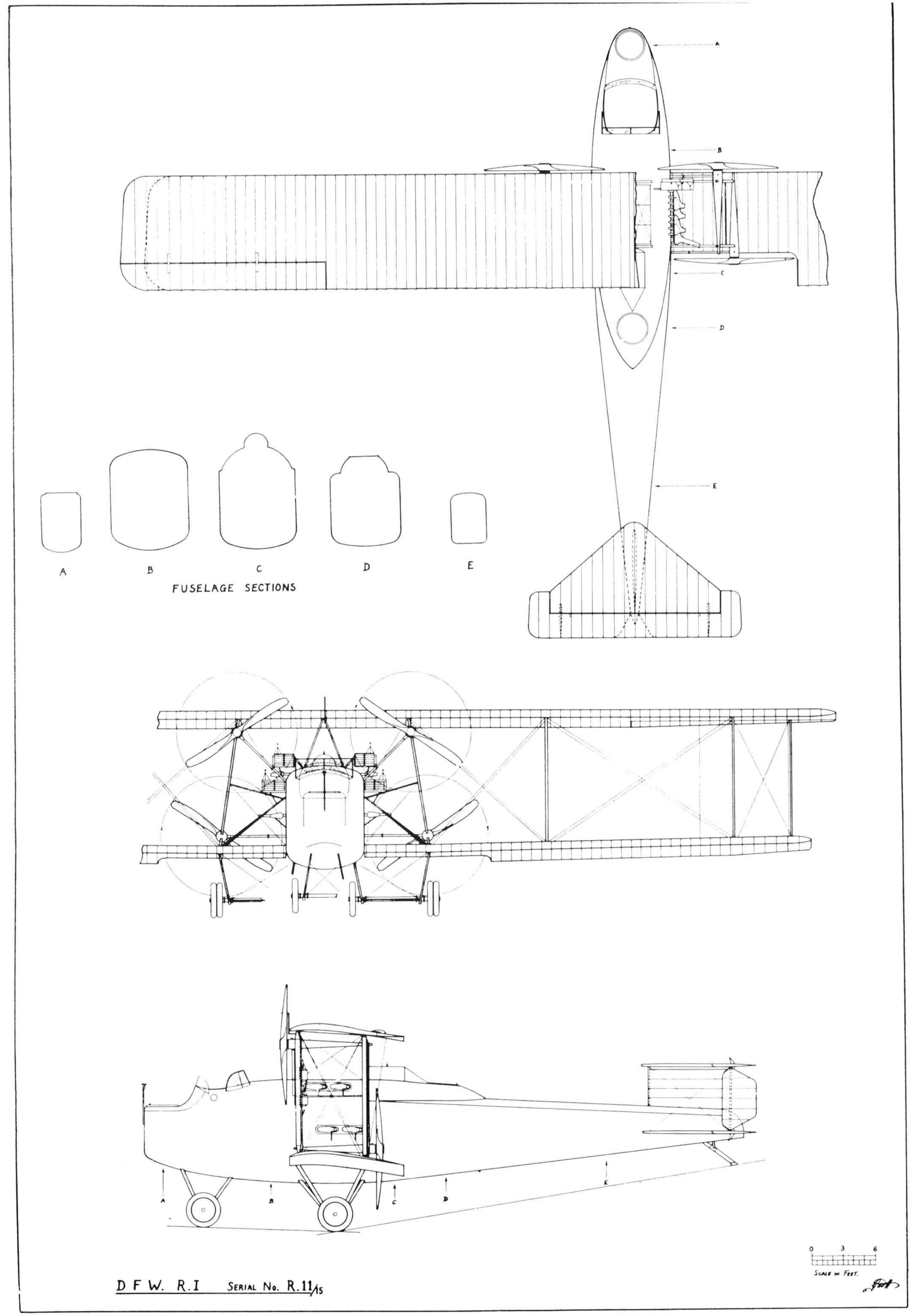
The DFW R.I 11/15 in its final form. The machine in the foreground is a SSW D.I fighter.

shaft required by the eight in-line cylinders of the Mercedes D.IV was very sensitive to vibration, and furthermore the Mercedes D.IV was never a very successful engine. Engineers traced the failures to the high frequency vibrations, which in turn could be traced to the light and poorly reinforced engine mounts. These were replaced by greatly strengthened mounts, while universal joints and other vibration reducing devices were installed in the drive system. The span was increased slightly, requiring the addition of an extra rear strut between the wing tips. These modifications were completed by March 1917.

The R.I was now ready for operational testing, and on 30 April it was flown from Döberitz via Königsberg to Alt-Auz, where Rfa 500 was stationed. Test flights were carried out during which it was found that the R.I could fly on two engines provided the speed was kept high and the aircraft was in light condition. At low speed with forward propellers disengaged the R.I had a tendency to stall. Three-engined flight was feasible only as long as the rudders were adjusted to counter the unequal thrust. The R.11 was returned to DFW for repairs and delivered anew in May 1917.

The one and only bombing mission flown by the R.I was on 13 June 1917 when it dropped 680 kg. bombs on Schlok in retaliation for an earlier Russian attack. It carried a crew of five: two pilots, two observers and one machinist. The career of the R.I ended in September 1917. It had taken off on a bombing mission when one of its engines failed and the commander decided to return to base rather than continue on three engines. On the return flight a gear-box began to overheat badly, and a second engine had to be stopped. It was impossible to keep the heavily-loaded aircraft in the air

DFW R.I 11/15. Note ventral machine-gun and large gravity fuel tank not fitted to the early version.



on two engines, so the decision was made to land on a nearby artillery training field. The R.I made a good landing in spite of ground fog, but during the landing run the wheels rolled into an unseen practice trench. The aircraft broke up, and upper fuel tanks spilled petrol on to the one remaining running engine. Shortly after the crew had left the aircraft it burst into fire and the bombs exploded. One crew member, whose petrol-soaked clothes caught fire, perished.

Colour Scheme and Markings

Initially the R.I was painted a light colour overall with black Patée crosses painted directly on wingtips, fuselage and rudders. The final version sported a two-tone camouflage on the upper areas of wings and tail and on the sides and top of the fuselage. All underneath surfaces were painted a light colour. National markings consisted of the black cross Patée on a white square background, painted on the wingtips, fuselage and rudders. The serial number R.11 was painted in black on the extreme front of the nose.

SPECIFICATIONS

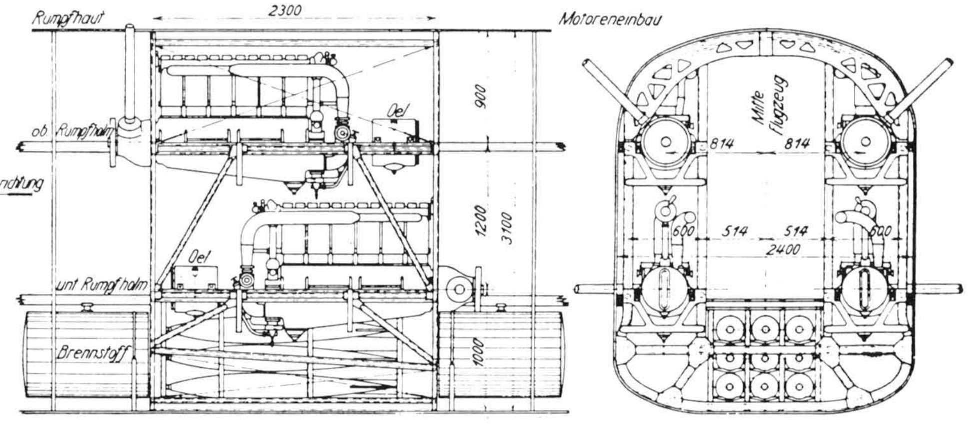
Type:	DFW R.I (first version)
Manufacturer:	Deutsche Flugzeugwerke G.m.b.H., Lindenthal near Leipzig
Engines:	Four 220 h.p. Mercedes D.IV engines
Propeller Revolutions:	900 r.p.m.
Dimensions:	Span, 29·5 m. (96 ft. 9 in.)
	Length, 17·6 m. (57 ft. 9 in.)
	Height, 6·0 m. (19 ft. 8 in.)
	Wheel diameter, 1·02 m. (3 ft. 4 in.)
Areas:	Wings, 182 sq. m. (1958 sq. ft.)
Weights:	Empty, 5652 kg. (12,462 lb.)
	Loaded, 8380 kg. (18,478 lb.)
Performance:	Maximum speed, 120 km.h. (75 m.p.h.)
	Climb, 1000 m. (3281 ft.) in 10 mins.
	2000 m. (6562 ft.) in 25 mins.
	3300 m. (10,827 ft.) in 53 mins.
Armament:	Provision for dorsal, ventral and nose machine-run positions
Service Use:	None

SPECIFICATIONS

Type:	DFW R.I (second version)
Manufacturer:	Deutsche Flugzeugwerke G.m.b.H., Lindenthal near Leipzig
Engines:	Four 220 h.p. Mercedes D.IV engines
Propeller Revolutions:	900 r.p.m.
Dimensions:	Span, 30·5 m. (100 ft.) approx.
	Length, 17·6 m. (57 ft. 9 in.)
	Height, 6·0 m. (19 ft. 8 in.)
Areas:	Wings, 186 sq. m. (2001 sq. ft.)
Weights:	Empty, 6800 kg. (14,994 lb.)
	Useful load, 2600 kg. (5733 lb.)
	Loaded, 9400 kg. (20,727 lb.)
Wing Loading:	51·7 kg. sq. m. (10·6 lb./sq. ft.)
Performance:	Maximum speed, 120 km.h. (75 m.p.h.)
Armament:	Provision for dorsal, ventral and nose machine-gun positions
Service Use:	Eastern Front with Rfa 500 at Alt-Auz, April 1917 to September 1917

DFW R.II

Flight tests had demonstrated that the R.I was endowed with adequate climb and manoeuvrability, and on this basis Idflieg placed an order on 13 November 1916 for six improved versions having a greater payload. The construction of these improved machines, designated R.II and numbered R.15/16 to R.20/16 (company designation T 26 II) was started on 10 December 1916 and differed from the R.I primarily in that the overall size was increased. The general impression is that of a simple well-designed, if somewhat bulky aircraft. The layout of the engines and the transmission system remained basically the same. The engine mountings were built of pressed steel and integral with the fuselage frames, forming a strong, compact centre-section structure which also supported wings, propeller mounts, landing gear and centre-section struts. Furthermore, the fuel tanks and bomb bay were located within this structure, thereby concentrating the stresses in a comparatively small but heavily reinforced frame-work.



DFW R.II. Engine arrangement.

Power was provided by four 260 h.p. Mercedes D.IVa engines which were coupled individually to the four propellers by bevel gears and carden shafts. Electric thermocouples allowed the pilots and flight-engineer to keep an eye on the running temperatures of gears and bearings. Cooling for the engines was by two large slab-shaped radiators, built by NFW, in the wing gap, above and to each side of the fuselage. Six fuel tanks, each of 350 litres capacity, rested on frames below the engines, and a gravity tank of equal capacity was fitted semi-externally on the fuselage decking.

The robust fuselage consisted of four wooden main longerons spaced by wooden bulkheads and reinforced by steel tube frames and cables. The floors and catwalks were an integral part of the fuselage structure and added to its stiffness. Twisting forces were a serious problem with the long fabric-covered fuselages of the early Staaken types, but the DFW R-planes with their doped fabric-covered plywood fuselages had no difficulty in this respect. The internal layout was conventional, consisting of a nose machine-gun position, followed by a spacious cockpit for the two pilots, and a separate commandant's cockpit to the rear on the starboard side. Beneath the cockpit was the usual wireless station followed by a passageway leading through the engine-room, the roof of which was fitted with windows that could be tilted up to provide extra ventilation. Farther aft were the dorsal and ventral machine-gun positions.

The three bay wings were constructed of wood and braced internally with steel compression tubes and double cables. Interplane struts were faired steel tubes, and all wing bracing was double cable. The lower wings incorporated dihedral and were cut away at their trailing edges to clear the pusher propellers. Balanced ailerons were fitted to the upper planes only. The empennage consisted of a biplane tail; the central fin and lower tailplane were an integral part of the fuselage and both tailplanes

were fitted with elevators. The king posts of the outboard rudders doubled as rear tail struts. All tail control surfaces were balanced.

The first R.II (R.15) made its maiden flight on 17 September 1917 successfully in all respects save one; serious vibrations were still very much in evidence in spite of greatly strengthened engine mounts. The problem lay in the high revolutions of the outrigger transmission shafts, and this was solved by encasing the shafts within stiffener tubes with the help of ball-races.

In March 1918 Sabersky-Müssigbrodt returned to DFW (which he had left in 1916 for LVG) and became the chief engineer of the R-plane section. On 1 April 1918 the R.15 was delivered to the Riesenflugzeugersatzabteilung (Rea: R-plane Support Section) in Cologne. The protracted development period of the DFW R-planes delayed their introduction into operational service; by then the

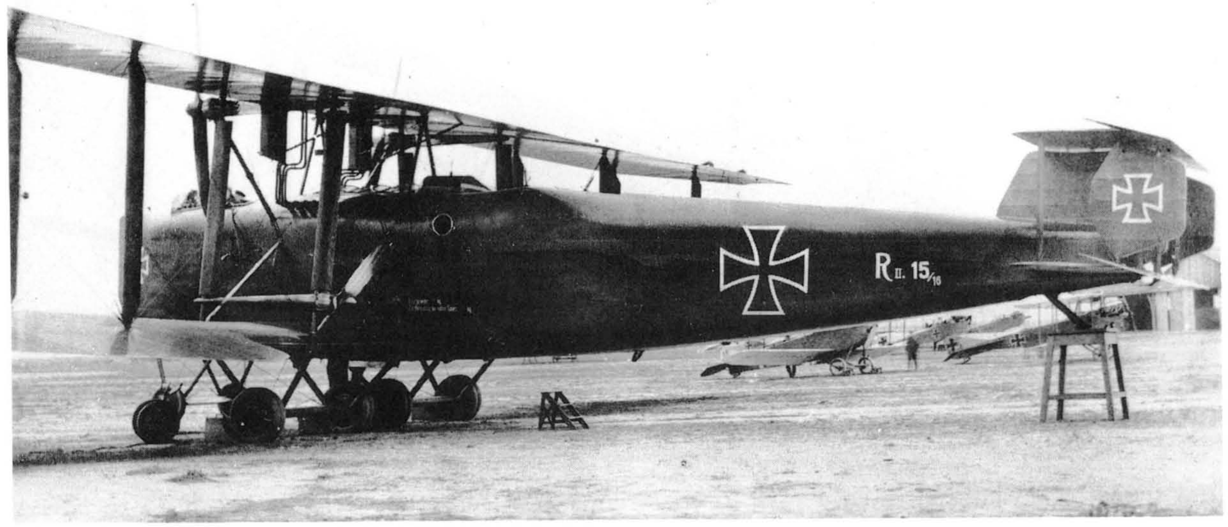
DFW R.II 15/16.

Staaken types had surpassed them in performance, reliability and load-carrying ability. Not one R.II ever saw active service; rather they were relegated to training air crews and performing experimental work. Sometime in 1918 the R.15 had a serious crash in which Oelerich was crippled for life.

The second R.II (R 16/16) was completed in February 1918; its performance was disappointing, and in April modifications were proposed in order to improve it. These included a lighter wing of increased size, removal of the nose landing-gear and relocation of the main undercarriage 80 cm. forward. The advisability of strengthening the fuselage was to be determined by static-testing one of the completed units. Not all these modifications were made; however, the proposal to install a supercharger was accepted. The report concludes with, "Only after full flight tests with the R.16, will the remaining four aircraft be completed."

On 21 May 1918 the R.16 was flown from Lindenthal to Grosszschocher for installation of the Brown-Boveri turbo supercharger driven by a 120 h.p. Mercedes D.II. Ground tests of the supercharger were conducted without a hitch, and the first test flight of the supercharged R.16 took place on 22 July 1918.

The supercharger supplied compressed air directly to the intake manifolds. The conduits for this passed along the outside of the fuselage. A small radiator was attached by brackets to the starboard side of the fuselage to provide cooling for the Mercedes engine. Other alterations included the fitting of exhaust collector manifolds, strengthening of the tractor propeller housings and fitting of a ramp for the ventral-gun position. Early flight test with the R.15 had shown that the aircraft was sluggish, so a third rudder was added to the central fin of the R.16 to improve manoeuvrability. Although ordered in 1916, the serial number of the R.16/16 was changed to R.16/17, reflecting perhaps



DFW R.II 15/16. *Photo. P. M. Bowers*

the shift of the R.16 programme to the 1917 budget. The R.16 was ready for operational service in October 1918.

By the war's end three of the six R.II machines ordered had been completed, the last being the R.17 which made its first flight on 22 July 1918. It has been claimed that the R.16 and R.17 were delivered to Rea in Cologne. The R.18 and R.19 were almost completed at the time of the Armistice, and Idflieg cancelled the R.20 due to the poor showing of its predecessors. In December 1918 the R.15 and R.17 were standing in the open along with other Rfa 500 and Rfa 501 aircraft

DFW R.II 15/16.

DFW R.II 16/17.

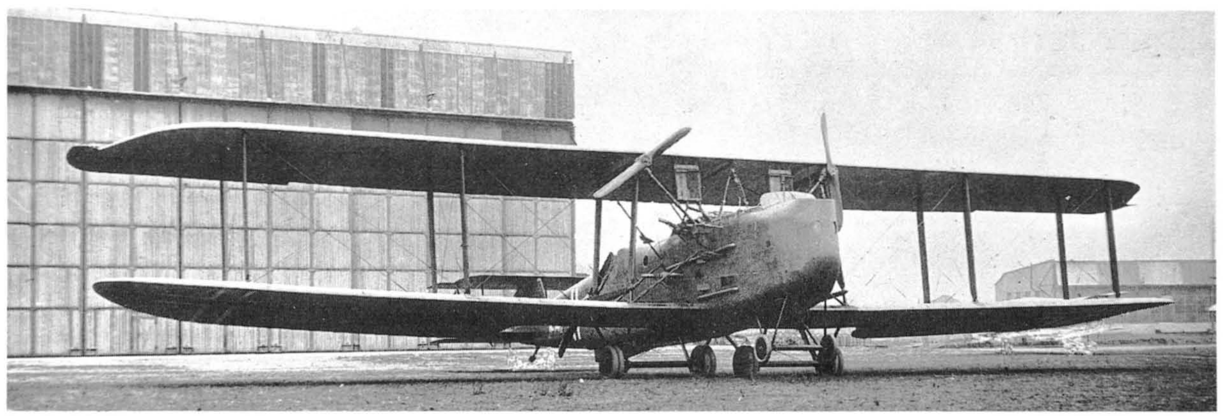
at Düsseldorf-Lohausen. Waldemar Roeder remembers his attempt to fly the R.15 to Kassel away from the danger zone on 24 December 1918, the last day it was allowed. Since all the technical personnel had dispersed, the crew consisted of five R-plane pilots. At first the weather was good, but in the Ruhr Roeder had to descend. When he gave full throttle again both port engines failed, and he was forced to land near Soest in Westphalia. In 1920, the R.15 was inspected by an Inter-Allied Control Commission team at Döberitz.

The Inter-Allied Control Commission found three R.II machines in the DFW hangar at Grosszschocher (near Leipzig) in 1919. In April 1919 an R.II was sent to Cologne to perform extensive tests for the Allies. This aircraft was most probably the supercharged R.16.

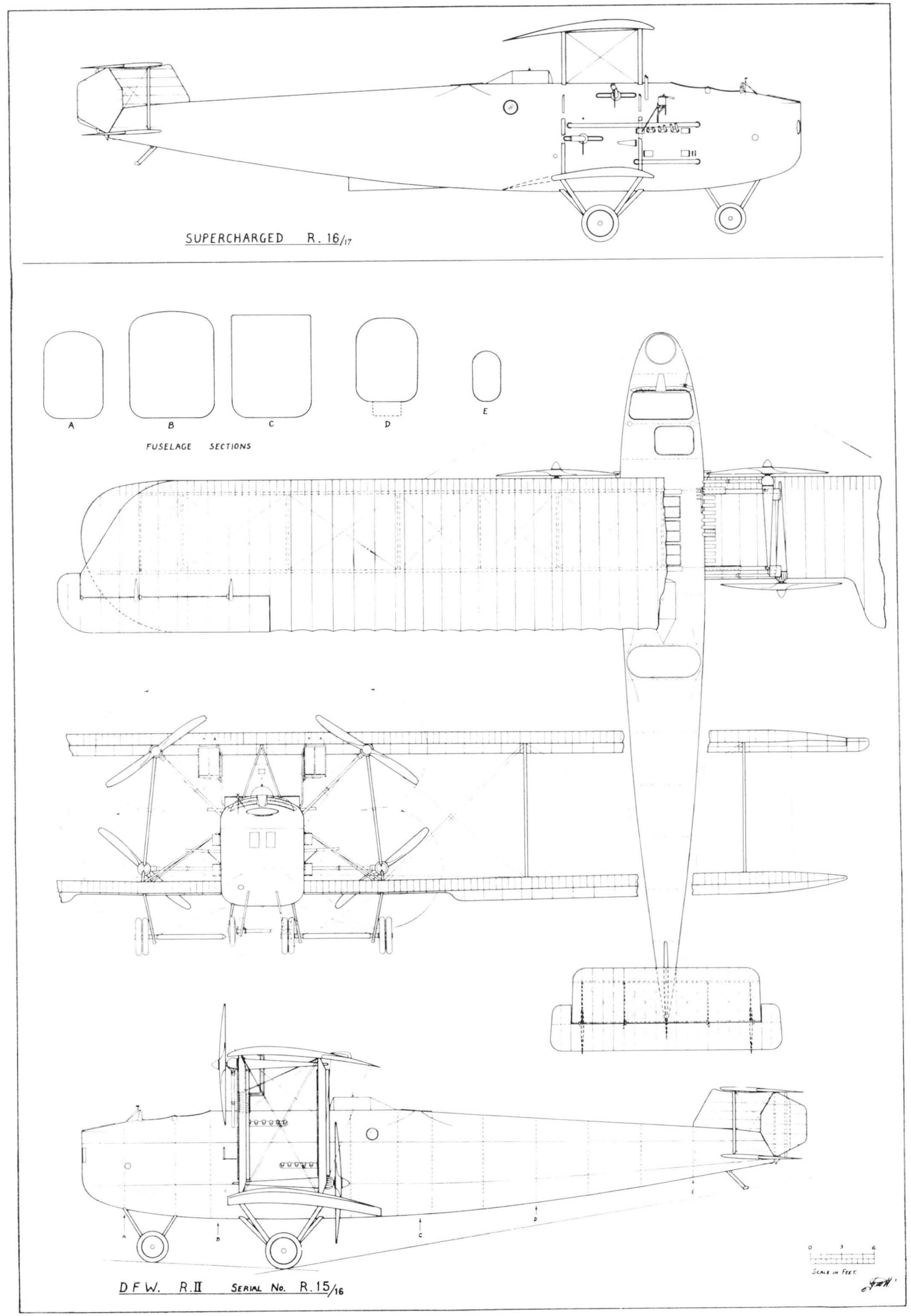
After the War DFW received permission and funds to complete the unfinished R.18 and R.19 as civil aircraft, and DFW planned to complete these as the F.26 twenty-four passenger transport. The F.26 was to have had two cabins separated by the engines, each seating twelve passengers, including ample space for luggage and sanitary arrangements. However, nothing came of the plan and the machines were scrapped.

Colour Scheme and Markings

The overall finish consisted of a two-tone camouflage pattern applied to the upper areas of wings, tail and on the sides and top of the fuselage. All underneath surfaces were painted a light colour. The R.15 carried the Patée crosses thinly edged in white. The R.16 had the late 1918 style Latin



DFW R.II 16/17. This was the supercharged model and the ducts carrying the supercharged air to the engines can be seen on the outside of the fuselage.



crosses spanning the full chord of the wings and rudders. The serial numbers were painted in white on both sides of the rear fuselage.

SPECIFICATIONS

Type:	DFW R.II
Manufacturer:	Deutsche Flugzeugwerke G.m.b.H., Lindenthal near Leipzig
Engines:	Four 260 h.p. Mercedes D.IVa engines
Propeller Revolutions:	915 r.p.m.
Dimensions:	Span, 35·06 m. (115 ft.)
	Chord, 4·4 m. (14 ft. 5 in.)
	Gap, 4·19 m. (13 ft. 9 in.)
	Length, 20·93 m. (68 ft. 8 in.)
	Height, 6·4 m. (21 ft.)
	Maximum fuselage depth, 3·1 m. (10 ft. 1 in.)
	Maximum fuselage width, 2·4 m. (7 ft. 10½ in.)
	Tail span, 6·7 m. (21 ft. 11½ in.)
	Propeller diameter, 3·5 m. (11 ft. 6 in.)
	Wheel diameter, 1·3 m. (4 ft. 3 in.)
Areas:	Wing, 266 sq. m. (2862 sq. ft.)
Weights:	Empty, 8634 kg. (19,038 lb.)
	Loaded, 11,693 kg. (25,783 lb.)
Wing Loading:	44 kg./sq. m. (9·01 lb./sq. ft.)
Performance:	Maximum speed, 135 km.h. (83·8 m.p.h.)
	Climb, 2000 m. (6562 ft.) in 58 mins.
Fuel:	2450 litres (539 Imp. Gals.)
Armament:	Provision for dorsal, ventral and nose machine-gun positions
Service Use:	Training duties with Rea, Cologne 1918
Cost:	500,000 marks

SPECIFICATIONS

Type:	DFW R.II 16/17	
Manufacturer:	Deutsche Flugzeugwerke G.m.b.H., Lindenthal near Leipzig	
Engines:	Four 260 h.p. Mercedes D.IVa engines	
	One 120 h.p. Mercedes D.II to drive Brown–Boveri supercharger	
Propeller Revolutions:	Same as R.15	
Dimensions:	Same as R.15	
Areas:	Same as R.15	
Weights:	Wings,	2036 kg.
	Fuselage,	1372 kg.
	Tail unit,	249 kg.
	Undercarriage,	853 kg.
	Engines,	1941 kg.
	Transmission,	1039 kg.
	Engine and supercharger,	1155 kg.
	Propellers,	202 kg.
	Armament,	185 kg.
	Empty,	9032 kg. (19,915 lb.)
	Fuel,	1440 kg. (3175 lb.)
	Disposable load,	2170 kg. (4785 lb.)
	Loaded,	12,642 kg. (27,875 lb.).
Wing Loading:	47 kg./sq. m. (9·6 lb./sq. ft.)	
Performance:	Unknown	
Armament:	Provision for dorsal, ventral and nose machine-gun positions	
Service Use:	Unknown	

DFW R.III

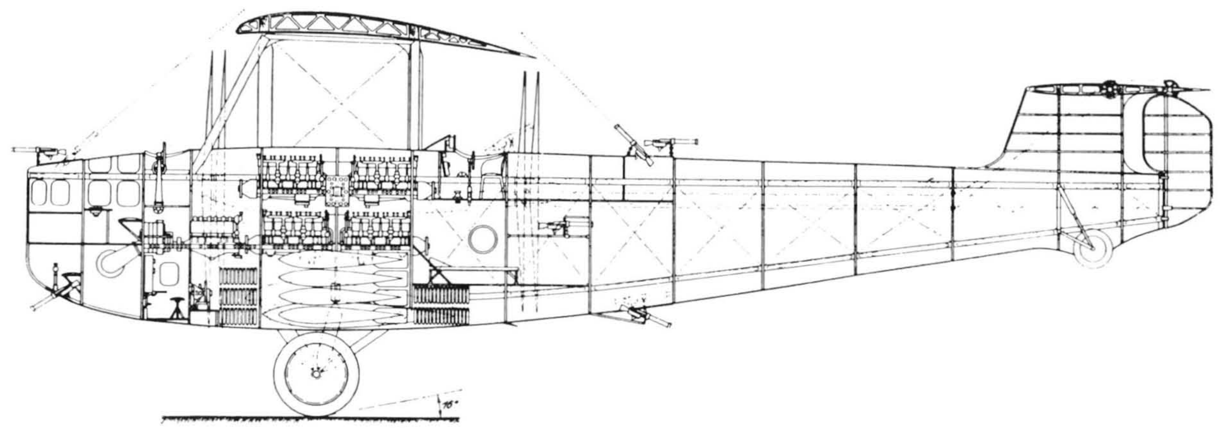
Because of the R.II's low performance, DFW already had a more powerful weapon on the drawing boards known as the R.III. Idflieg ordered two on 3 September 1918. The design work, under the direction of Dipl.-Ing. Willy Sabersky-Müssigbrodt was well advanced at the time of the Armistice.

The DFW R.III project was a direct progression of the R.II and similar in many respects except size. The initial proposal called for eight 260 h.p. Mercedes D.IVa engines, each separately connected to eight counter-rotating propellers arranged in a paired tractor and pusher configuration. Exhaustive tests were completed to investigate the efficiency of this combination. Another proposal had four airscrews each driven by two engines coupled through the transmission shaft. The propeller gear-boxes were enclosed in a patented wing-mounted nacelle which also contained the fuel tanks. One (or two) superchargers, each driven by a 120 h.p. engine, maintained performance to 5000 metres. It has been stated that these engines were also to have been used to start the main engines.

An unusual feature which was included at the request of Idflieg was the separate navigator's steering station placed well ahead of the wings, whereas the dual cockpit was located directly under the trailing edge of the wings. The navigator could make only small corrections in course with his auxiliary rudder control, but this was considered a very useful feature during the critical landing manoeuvre and bombing-run approach.

The massive, double-decked fuselage was of sufficient size to hold 2500 kg. of bombs as well as eight machine-guns, sleeping bunks, wireless station, bomb aimer's post and navigator's cabin. Contrary to the biplane tail units employed on earlier DFW giants, the R.III was to have had a single tailplane mounted on top of the fin and rudder. In place of the tail skid a neatly-faired tail wheel was to have been installed.

The serial number (if any) allocated to the R.III is not known.



Internal arrangement of the DFW R.III project.

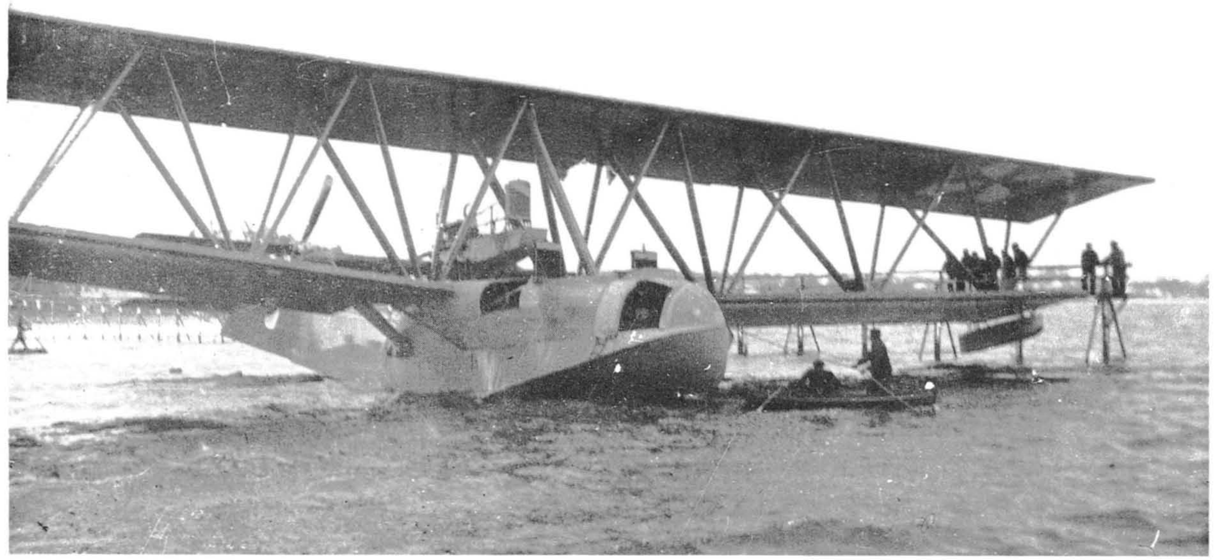
SPECIFICATIONS

Type:	DFW R.III (Project)
Manufacturer:	Deutsche Flugzeugwerke G.m.b.H., Lindenthal near Leipzig
Engines:	Eight 260 h.p. Mercedes D.IVa engines
	One or two 120 h.p. Mercedes D.II engines to drive superchargers
Dimensions:	Span, 53·5 m. (175 ft. 6 in.)
	Chord, 6·4 m. (21 ft.)
	Gap at fuselage, 6·5 m. (21 ft. 3 in.)
	Gap at wingtips, 5·75 m. (18 ft. 10 in.)
	Length, 25 m. (82 ft. 0½ in.)
	Height, 8·6 m. (28 ft. 2½ in.)
	Maximum fuselage depth, 3·9 m. (12 ft. 9½ in.)
	Tailplane chord, 4 m. (13 ft. 1½ in.)

Dornier Rs.I

The giant Dornier flying-boats signified the beginning of an aircraft enterprise that still exists today as the oldest German aircraft concern. Its longevity is due in great measure to its brilliant founder, Claudius Dornier, who, after having built and lost an aircraft empire, has had the satisfaction of experiencing its rebirth.

Dornier, born in 1884, had joined the experimental design offices of the Luftschiffbau Zeppelin in 1910 after three years work with several steel construction firms. At first he was engaged in a variety of airship problems, among them: stress calculations, propeller theory, preliminary investigation of a metal-clad airship and the design of a rotating airship hangar which earned him a prize and a patent, one of the many assigned to him in his lifetime. From the beginning, Dornier proved himself a thorough and creative engineer, endowed with the ability to reduce ideas to practical use. These

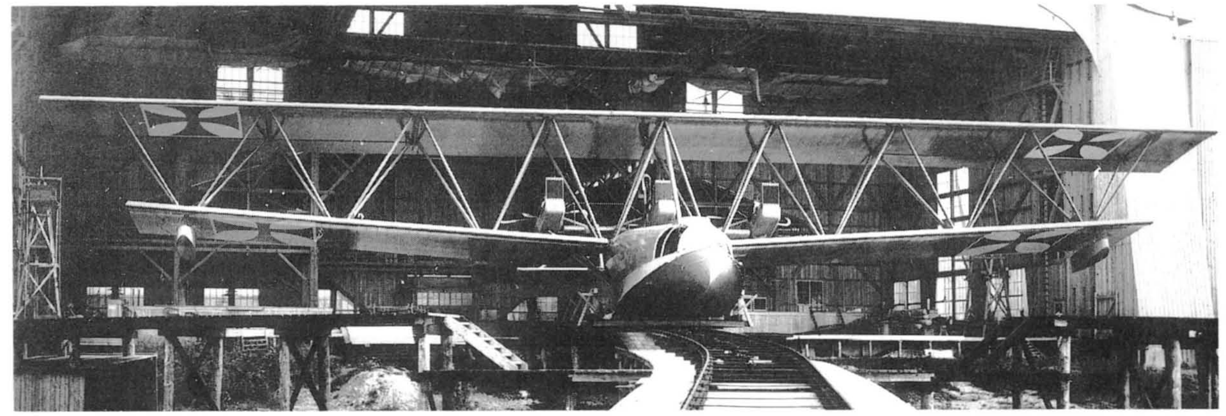


The original form of the Dornier Rs.I with two buried engines. The damage done to the upper wing trailing edge by the shattering of the port propeller can be seen. Photo taken 23 October 1915.

talents soon caught the eye of Graf Zeppelin, with the result that in 1913 Dornier was transferred to Graf Zeppelin's private design bureau in Friedrichshafen to work on an 80,000 cubic metre steel airship capable of flying across the Atlantic. This behemoth, three times the size of existing airships, was to have been completed for the Düsseldorf World's Fair of 1916, from which it was to fly to America and then on to the San Francisco Exposition. However, war intervened, and the ambitious project was abandoned.

As described elsewhere, Graf Zeppelin organized the VGO-Staaken venture in 1914 to construct a giant wooden bombing aircraft as quickly as possible. At the same time, however, Graf Zeppelin, believing in the ultimate superiority of all-metal construction, commissioned Dornier to undertake the more formidable task of building all-metal seaplanes. Dornier collected his small design staff and moved into an old airship hangar at Seemoos, on the shores of Lake Constance, to begin his revolutionary work. The new organization was known as Zeppelin-Werke Lindau, G.m.b.H., although the aircraft built by this firm were all designated "Dornier".

In 1914 metal was an uncommon construction material for aircraft, but Dornier and his engineering staff approached the problem of developing lightweight structures with vigour and ingenuity. Alu-



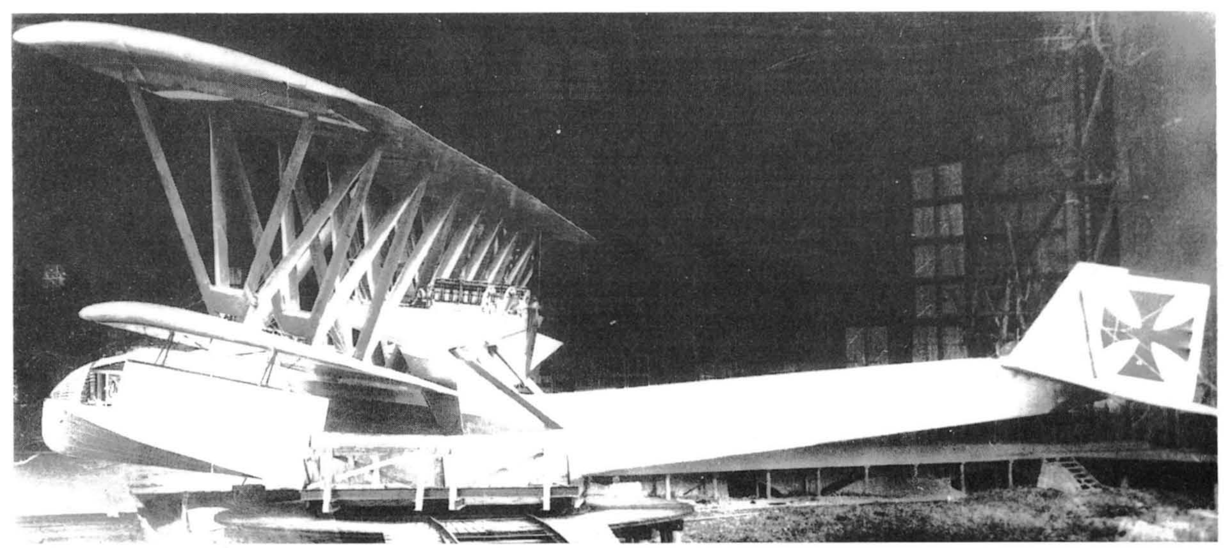
The modified Dornier Rs.I outside the hangar at Seemoos in December 1915.

minium was available, but in its unalloyed state it was a relatively low-strength metal. Progress had been made with aluminium alloys such as the newly-developed duraluminium, an alloy which doubled the strength of aluminium, but, being new, still suffered from a number of faults. A Dornier engineer had this to say about the material:

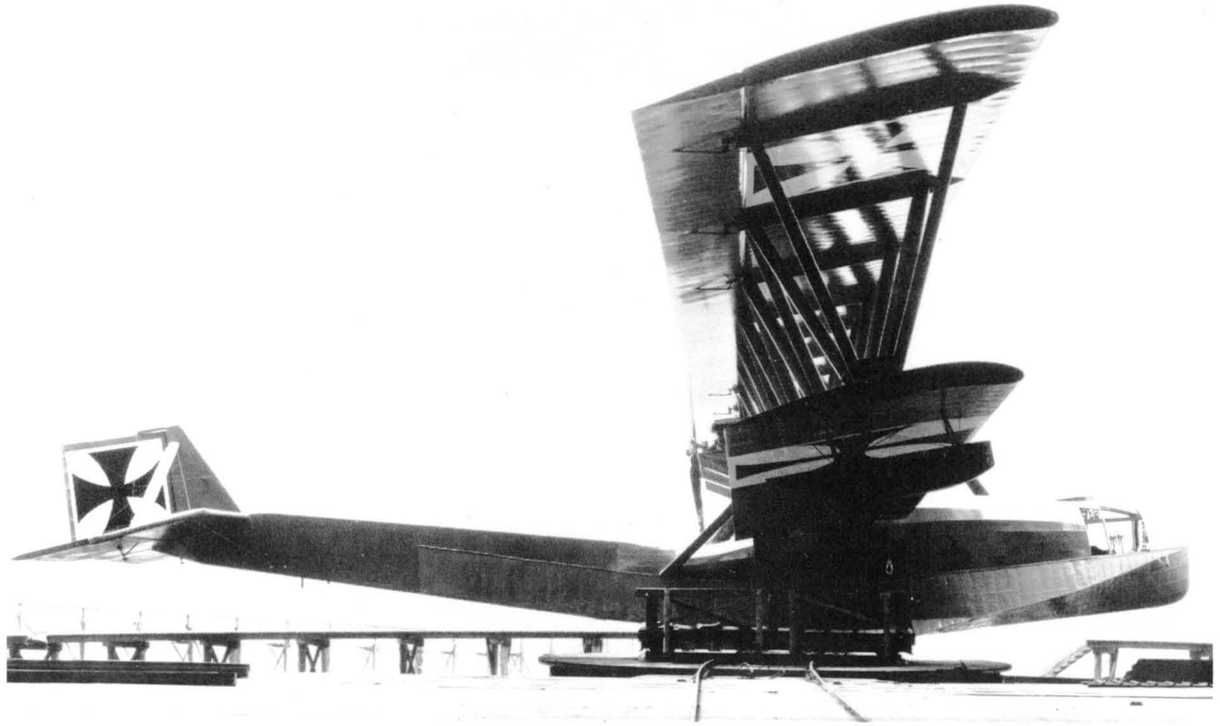
> Dural was a brand new material in 1914, available only for experimental use. It had many drawbacks. For instance, it was not produced in consistent quality; more often than not a rolled Dural sheet would exfoliate like the leaves of a book. Impurity inclusions caused frequent embrittlement cracking and after brief periods of storage, the Dural sheet had the unpleasant tendency to disintegrate in spots to a white powder.

Although an airship using duraluminium parts was placed into service in early 1915, the very promising metal was not yet suitable for all-round aircraft use. Dornier therefore decided in favour of a mixed construction technique using principally high-strength steel for his first all-metal aircraft, with less-stressed sections formed from duraluminium.

At first glance it would appear that steel tubing would make an ideal structural medium, for it was light, easy to produce and possessed a high strength-to-weight ratio. Yet from Dornier's point of view it was far from perfect. Tubes are extremely difficult to join with bolts and rivets, and invariably



Dornier Rs.I.



Dornier Rs.I.

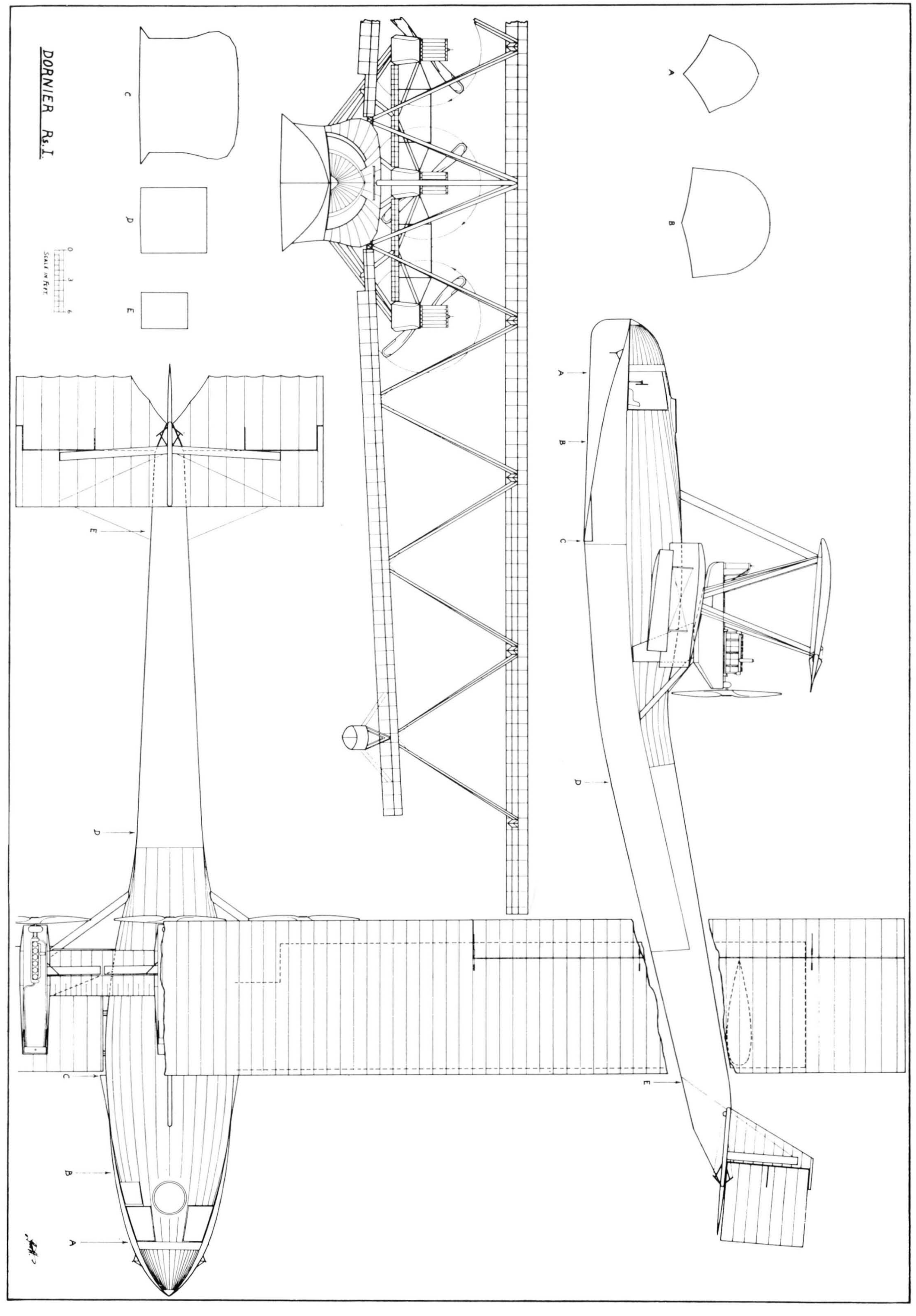
a weakening of the structure takes place. Welding, at the time, was considered still unreliable; inspection of the welded joint was not foolproof, and the high welding temperatures involved had a tendency to weaken the metal, although this situation was to change later in the war. Finally, the many sizes of tubing required would entail extensive storage facilities and place Dornier at the disadvantage of being dependent on the producer for special tube sizes.

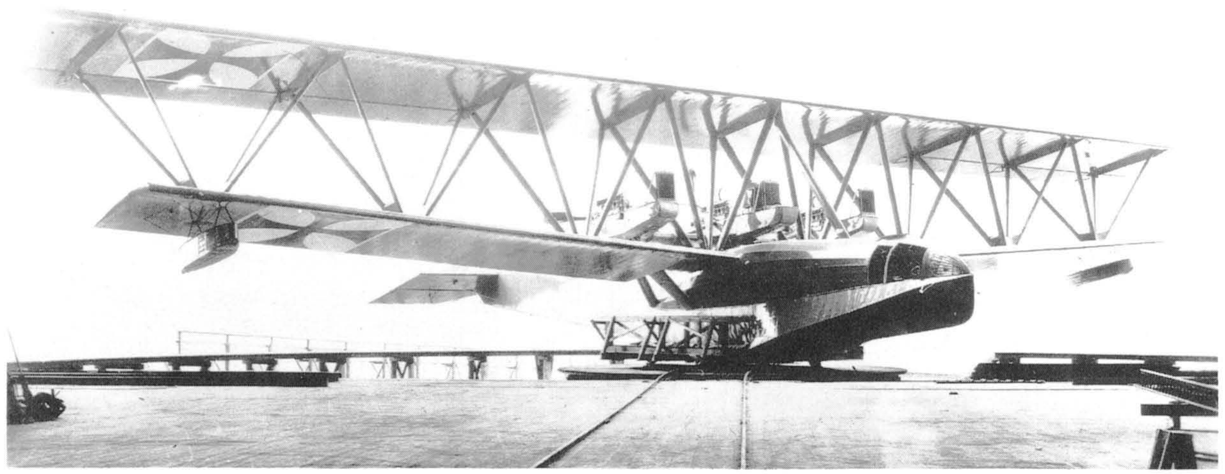
Dornier chose to exploit the ingenious construction method which he had developed and was perfecting for the transatlantic airship project. The starting material was alloy steel strip of varying widths and thicknesses, which had the advantage of being easy to fabricate, ship and store. The strip was then readily drawn or rolled into hollow-flanged profiles (for example, open flanged, "clover leaf" and V-shapes) of different dimensions as the occasion required. An inverted U profile was then placed into the open end of the "clover leaf" and joined with rivets. The extended flanges provided a surface to which other profiles and structural parts could easily be fastened. This method of forming structural members and variations thereof not only remained Dornier's basic structural philosophy for years, but virtually was the foundation for modern all-metal aircraft construction techniques the world over. These shapes possessed higher buckling strengths and had better resistance to breaking than tubing of similar weight and cross-section. Furthermore, an infinite variety of shapes could be formed to suit every structural requirement of the aeronautical engineer.

The design of the all-metal Dornier Rs.I was begun in August 1914, and by January of the following year the actual assembly work had begun. Former Dornier test pilot, Erich Schröter, recalls that Graf Zeppelin followed with deep interest every detail of the Rs.I assembly. In spite of his advanced years, he would not hesitate to climb an extended fire ladder to watch the huge wings being lowered on to the hull. The Rs.I was a private venture, and as such it was not assigned an official Navy identification number.[1]

The framework of the Rs.I was constructed primarily of alloy steel using Dornier's ingenious double-flanged shapes, perforated girders, built-up triangular sections and stamped sheet. The uncovered frame of the Rs.I had all the earmarks of contemporary airship structure. In spite of its

[1] The first two Dornier R-seaplanes were also at one time designated by the company as FS.I and FS.II (for Flugzeug Seemoos or Flugschiff), but the Rs designation later became standard.





Dornier Rs.I.

shortcomings, duraluminium was used for light unstressed structural parts as well as for the lower fuselage covering.

The wings were of relatively narrow chord considering their great span. The upper wing was constructed around four built-up truss spars, two of which formed the supporting structure, while the remaining two were designed to take pure bending loads which were transferred to the main structure at the junction points. Duraluminium rib profiles were riveted to the spars to form the airfoil section, and they were internally braced by diagonal cross-members. The ribs were wrapped with linen strips to which the wing covering was sewn. The lower wing consisted of a similar three-spar structure that was attached to a fuselage pivot point, in a manner that permitted the angle of incidence of both wings to be varied by changing the length of the forward fuselage strut. The lower wing had slight dihedral, and two small duraluminium stabilizing floats were mounted at the wing tips.[1] Unconventional triangular wing struts, reminiscent of the Warren truss when viewed head-on, eliminated the need for interplane cables. The huge unbalanced ailerons were unusual in that they spanned half the length of the upper wing.

The Rs.I hull was of orthodox design, single-stepped, with the tail section rising gently to keep the tail well above water. The planing surface and the sides of the hull were covered with sheet duraluminium, while the top and rear were covered with fabric. The pilots sat in a large square cockpit in the nose behind a rather awkward Cellon canopy which must have seriously restricted their forward view. A machine-gun ring was mounted in the cabin roof just behind the pilots' seats. Consistent with Graf Zeppelin's "bomb in harbour" theory,[2] provisions were made to carry a 1000 kg. bomb in the hull. In what was perhaps the first test of its kind, models of the Rs.I hull were extensively tested in the indoor tow tank of the Kgl. Versuchsanstalt für Wasserbau und Schiffbau (Berlin) beginning in September 1914. Today, of course, such tests are taken for granted.

The simple square monoplane tail assembly was strut-braced and a small triangular fin supported a perfectly square rudder. The tail surfaces were balanced by hingeing them some distance behind their leading edges. All surfaces were covered with linen.

In October 1915 the Rs.I emerged from its hangar at Seemoos, the largest aircraft in the world, with a wingspan of over 142 feet. This in itself was a remarkable achievement made even more incredible by the fact that the Rs.I was constructed wholly of metal. The machine at this point was powered by three 240 h.p. Maybach HS (or Mb.IV) engines, two of which were buried in the hull and drove two pusher propellers mounted on the lower wings. The drive system, similar to that used on airships, consisted of the usual outrigger shafts and bevel gear-boxes to transmit power. The third engine,

[1] Early project drawings show the stabilizing floats mounted just outboard of the engines.
[2] See Staaken chapter, page 209.

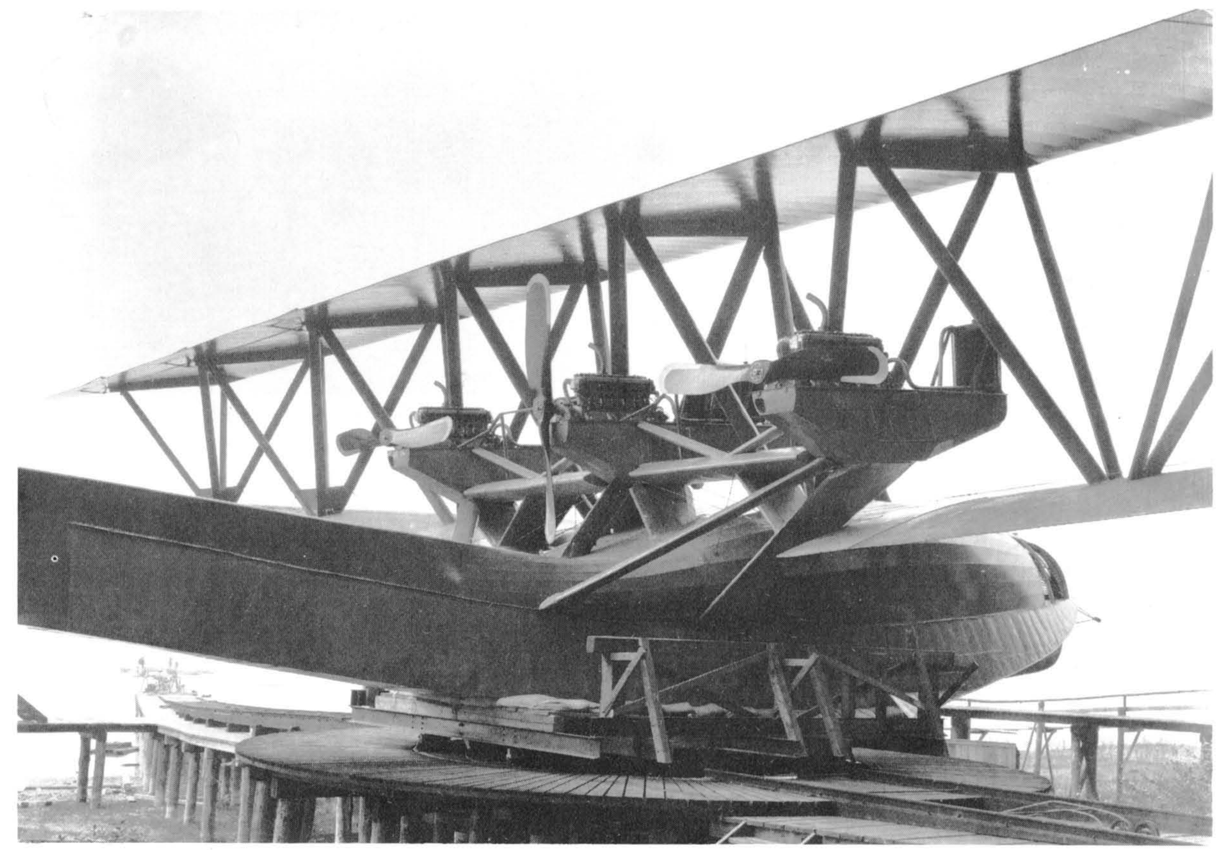
directly driving a pusher propeller, was mounted in the wing gap above the hull. The buried engines were cooled by two radiators fixed to the fuselage decking, while the third radiator was mounted in front of the central engine. The Rs.I taxying trials began on 12 October 1915 with test pilots Hellmuth Hirth and Erich Schröter at the controls. Further tests, conducted on 15 and 16 October, resulted in a taxying speed of 40–50 km.h. This was still some 30–40 km.h. below the calculated lift-off velocity. A sudden end to tests came on 23 October when the port propeller or drive fractured and fragments tore the trailing edge of the upper wing. Dornier himself wrote that the unreliability and complexity of the outrigger drive system, its inability to transmit high forces and the problem of mounting it rigidly, finally forced him to dispense with the buried engine. Another reason, perhaps, for modifying the Rs.I may have been to raise the propellers. Fixed to the lower wings as they were, they may have been badly battered by the heavy spray which the Rs.I was capable of kicking up. In any case, the three Maybach engines were placed between the wings on an integral engine mount consisting of broad streamlined girder struts fixed to the fuselage, completely independent of the wing structure. The engines were connected to each other by a streamlined cat-walk fitted with hand-rails, so that mechanics could move among and service the engines in flight.

Presumably the Rs.I carried out scores of taxying trials, for the inhabitants on the shores of Lake Constance made fun of it with this doggerel:

That is the flying-boat from Seemoos.
From the lake it can't come loose.

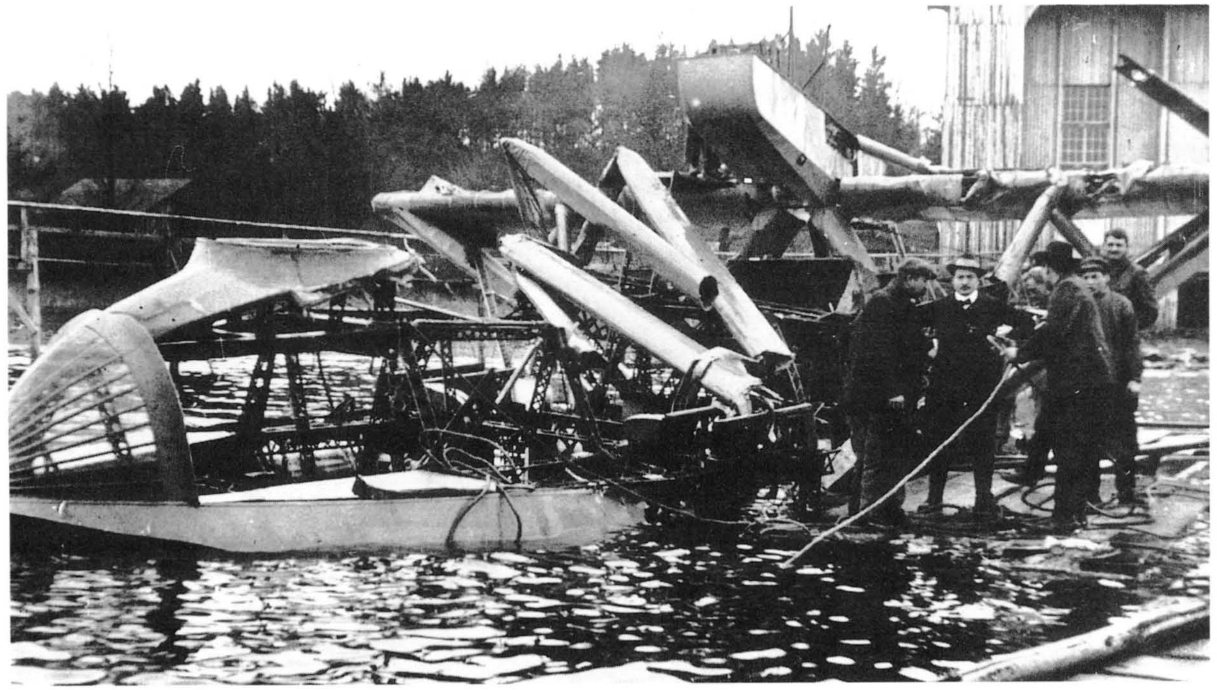
They were right. The Rs.I never did fly. On its fifth and final trial it came to grief.

Here is what the Dornier test pilot, Erich Schröter, wrote of that fateful day, 21 December 1915, when the Rs.I was destroyed:



Close-up of the modified engine layout of the Dornier Rs.I.

Preliminary engine and taxying trials were being carried out when the treacherous Föhn wind, common to the Lake Constance area, made its sudden and unexpected appearance. We immediately made preparations to bring the Rs.I back into the hangar, when the slipway on which the aircraft rested sideways to the wind, jammed. The Rs.I was in great danger of immediate destruction, but we managed to relaunch it. Using all engines to keep the aircraft heading into the violent gusts, we succeeded in mooring the Rs.I to a buoy. It soon became evident that the mooring would part, threatening the Rs.I with destruction on the rocks. Night fell quickly. About 11 p.m. a packet boat ventured near in an attempt to take off the storm-tossed crew, but was unable to do so as it was in danger of foundering. The only chance of saving the Rs.I appeared to be for one of the large lake steamers from Friedrichshafen to tow the aircraft out to the middle of the lake, there to ride out the storm away from the danger of the nearby rocks. However, owing to the extreme conditions, all steamship traffic on Lake Constance had been halted. Those on land saw the giant aircraft buffeted by the waves until the early morning when the moorings broke, and the Rs.I was driven on to the waiting rocks and there pounded to pieces.


Wreckage of the Dornier Rs.I after its destruction in a storm.

This incident was to cause great consternation among naval engineers and constructors concerning the best means to shelter these fragile aircraft from the elements.

The Rs.I, although it never took to the air, provided a valuable proving ground for new structural techniques, many of which were incorporated in later Dornier designs with much success. As an aircraft, the all-metal Rs.I will always stand high among the great aircraft of the world for its daring concepts, great size and technological pioneering.

Colour Scheme and Markings

The black cross Patée superimposed on a square white background was painted on both upper and lower wing surfaces of both wings, and on the rudder surface.

SPECIFICATIONS

Type:	Dornier Rs.I
Manufacturer:	Zeppelin-Werke Lindau G.m.b.H., Seemoos, Lake Constance
Engines:	Three 240 h.p. Maybach HS (Mb.IV) engines
Dimensions:	Span upper, 43·5 m. (142 ft. 9 in.)
	Chord, 4·6 m. (15 ft. 1 in.)
	Span lower, 37·75 m. (123 ft. 10 in.)
	Chord, 3·6 m. (11 ft. 10 in.)
	Length, 29·0 m. (95 ft. 1½ in.)
	Height, 7·2 m. (23 ft. 7½ in.)
	Hull length, 27·4 m. (89 ft. 10½ in.)
	Hull beam, 3·5 m. (11 ft. 6 in.)
Areas:	Wings, 328·8 sq. m. (3538 sq. ft.)
	Tailplane, 27 sq. m. (291 sq. ft.)
	Elevators, 16 sq. m. (172 sq. ft.)
	Rudder, 10 sq. m. (108 sq. ft.)
	Fin, 5·3 sq. m. (57 sq. ft.)
	Ailerons, 24·8 sq. m. (267 sq. ft.)
Weights:	Empty, 7500 kg. (16,537 lb.)
	Loaded, 10,500 kg. (23,153 lb.)
Service Use:	None

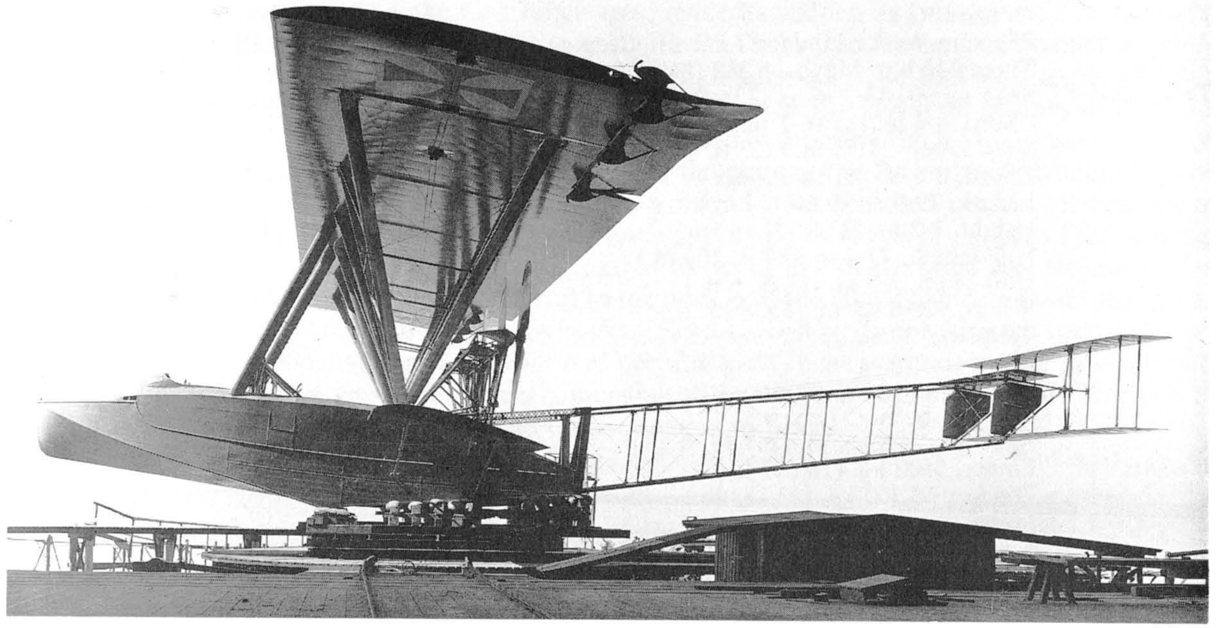
Dornier Rs.II

Spurred on by the sudden loss of the Rs.I, Dornier and his staff worked vigorously to complete their second flying-boat, the Dornier Rs.II. The design and construction drawings for the aircraft had been prepared during 1915, and the relatively short construction time suggests that portions of the Rs.II had already been completed prior to the destruction of the Rs.I. Although built of the same materials, steel and aluminium, the Rs.II design had little else in common with its predecessor. The most important change was the broad hull, which was the first step towards Dornier's distinctive and practical inherently-stable hull designs. Other changes included a broad, low-aspect-ratio upper wing, an open tail boom structure and an unusual tail configuration.

It is interesting to speculate on the reasons why Dornier continued with the buried-engine system after it had failed in the Rs.I. It is surmised that the transmission had been completed and perhaps even bench-tested and that consideration of expenses and expediency warranted giving the buried-engine system another chance. However, Dornier was not satisfied with remotely-driven propeller systems, and he began a series of experiments in early 1916 to thoroughly investigate the feasibility of other propeller and engine arrangements. The first experiment, an examination of the efficiency of the tandem engine lay-out, was conducted by Dornier's long-time associate, Dipl.-Ing. Schulte-Frohlinde. In the test the engines were mounted back to back on a large test stand and the thrust of individual tractor and pusher propellers was compared with the thrust of the propellers running in tandem. The tandem arrangement, contrary to expectations, was found to have a negligible thrust loss, and this fact had important consequences for the Rs.II and many subsequent Dornier types. This system was used on many Dornier aircraft throughout the Thirties until the end of World War II.

Initially, the Rs.II was powered by three 240 h.p. Maybach HS (or Mb.IV) engines mounted within the hull and driving three pusher propellers supported between the upper wing and hull on a lattice-girder framework. The engine radiators were mounted as a wide slab on top of the hull behind the pilot's cockpit.

The upper wing had a very low aspect ratio of 5 : 1 in order to distribute the great weight of the aircraft over a small beam length. The wing was mounted above the hull by two great N struts at



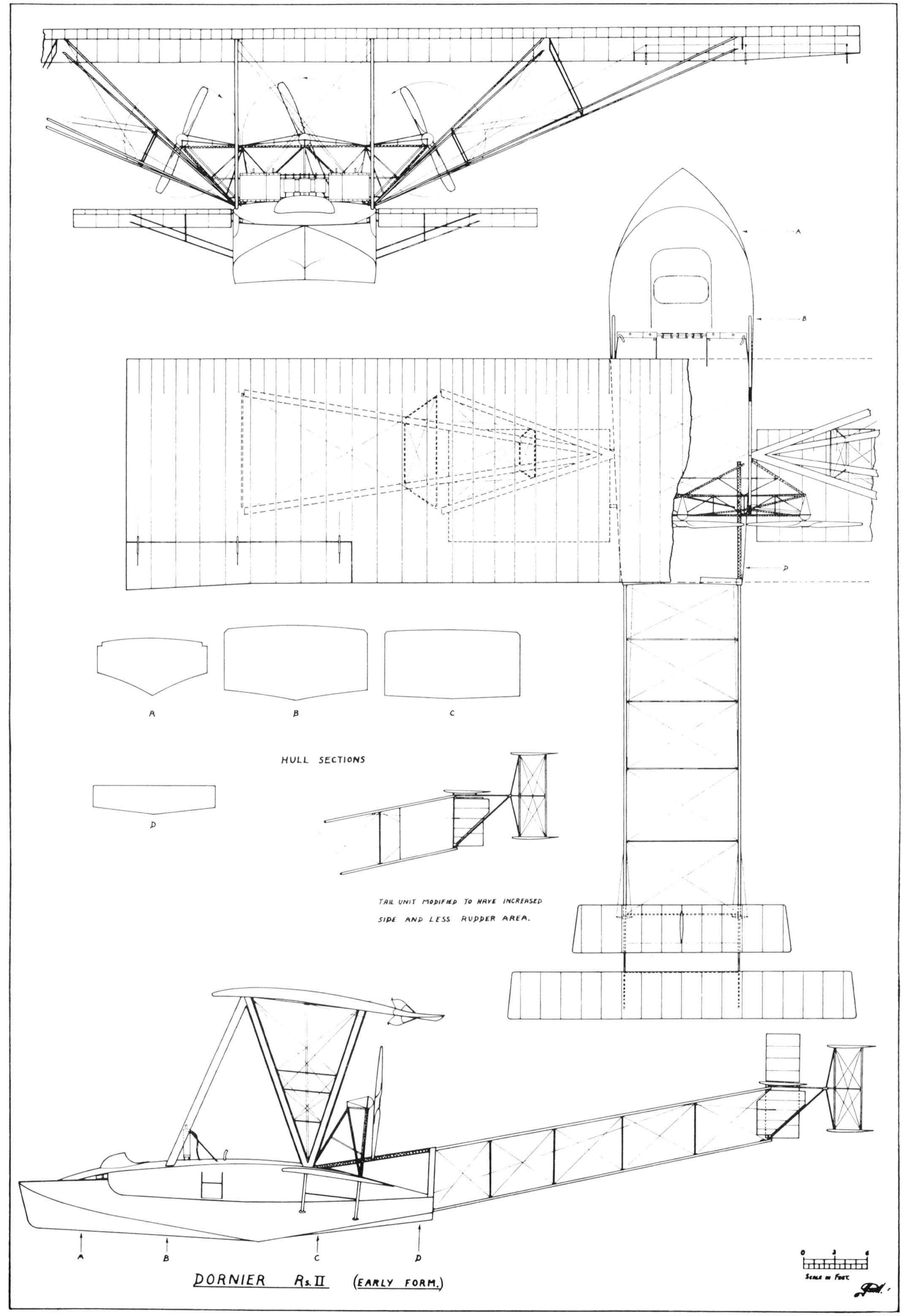
Original form of the Dornier Rs.II with buried engines.

the centre section. The bottom apex of the N was a pivot point from which ran two V struts that supported the outer wing structure. As with the Rs.I, the length of the forward leg of the N could be changed to vary the angle of incidence of the wings. The small lower wings were used, in Dornier's words, primarily to support wingtip floats, but initial flotation tests proved these floats unnecessary and they were removed. This marked the origin of the Dornier inherently stable flying-boat hull, which was destined to be a Dornier trade-mark for many years. The small stub wings were retained for the amount of extra lift they provided, but they were discarded on succeeding flying-boat designs.

Three built-up girder spars of triangular section formed the primary wing structure, which included the Dornier practice of aluminium ribs spaced fairly wide apart. The wing fabric was sewn to special eyelets attached to the framework at evenly spaced intervals. This method of holding down fabric proved very successful and later found application in airships. The ailerons were unbalanced. To improve lateral control at near stalling speeds the tip incidence was "washed-out".

The crew was situated near the bow in a large open cockpit protected by a raised streamlined coaming. The central and rear hull section contained the buried engines and fuel tanks. The hull was built of steel bulkheads and stringers. The sides and bottom of the hull were covered with duraluminium, whereas fabric was used for portions of the decking. The tail was supported by an uncovered box framework composed of four tubular booms joined by a series of vertical and horizontal struts reinforced by diagonal cables. The two lower booms ran directly into the end of the hull, while the upper booms were attached to a combination lattice-girder V-strut structure. The lattice girders continued the boom line and were anchored deep in the hull. The tail was left uncovered to avoid buffeting from the water spray, which Rs.I taxying trails had shown to be unpleasantly high and heavy. The tail assembly consisted of a small fixed tailplane mounted to the upper booms. Two rudders, which were rather small for an aircraft this size, were hinged between the booms below the tailplanes. An all-flying biplane cellule was awkwardly hinged behind the rudders and took the place of elevators. The tail assembly does not seem to have been thoroughly engineered, and its appearance suggests that structural simplicity was forfeited for questionable control advantages.

Such was the appearance of the Dornier Rs.II when it left the Seemoos hangar for its taxying trials on 17 May 1916. Test pilot Schröter recalls the event:



Graf Zeppelin was present to observe the launching. With him aboard his motorboat *Württemberg* were Dornier, Oberingenieur Dürr, Generaldirektor Colsman, Direktor Winz and Dr. Eckener. At my request Ing. Schulte-Frohlinde occupied the co-pilot's position. With the engines throttled back, I taxied to the Swiss side of the lake, there we turned and, heading into a mild breeze, I gave full throttle. The Rs.II sped forward, but the speed obtained was insufficient to raise the hull on to its step in such placid water conditions. Later the *Württemberg* attempted to break up the water surface for us, but it was useless and the Rs.II was brought back to the hangar.

A total of six water-borne tests were conducted during which it became necessary to increase the rudder area to improve manoeuvrability. This was done by adding a tall third rudder between the tail booms and controlled by cables attached to the outer two rudders. The Rs.II was now ready for its maiden flight.

Schröter continues:

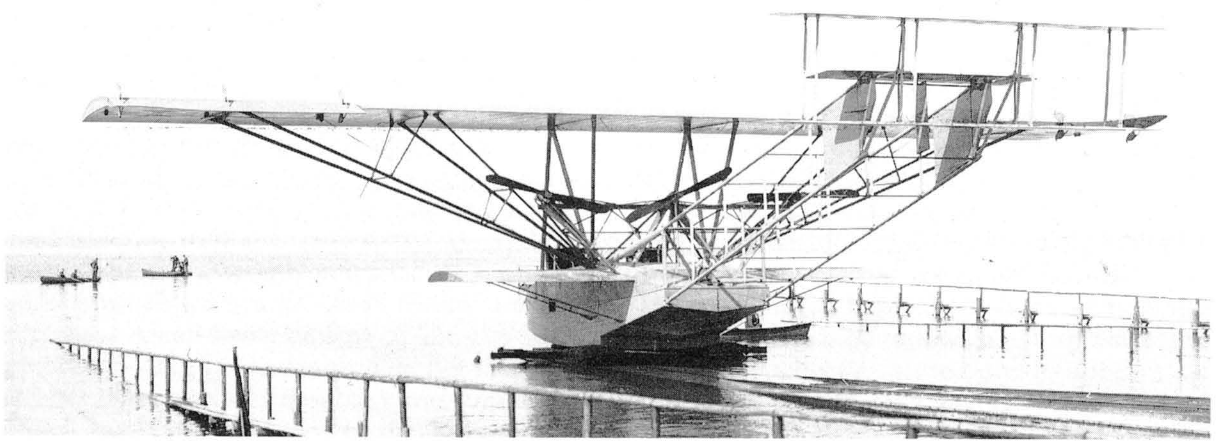
On the next attempt (30 June 1916) we had a sufficient wind. Aboard, besides myself, were Schulte-Frohlinde, Dr.-Ing. Adolf Rohrbach, Ing. Lindner, and four engine mechanics. After manoeuvering into position, I opened the throttles and we sped over the lake. I gave a slight tug on the controls, the Rs.II raised on its step. The wind had helped. With precise motion, I gently pulled the wheel toward my chest. Now a springy jump from wave to wave. The jolts ceased; we were in the air. How easy it all was, almost as if I had a fully-proven aircraft in my hands.

Carefully I prepared to land. With throttled engines, the Rs.II willingly lowered its nose and glided to a landing. A sudden splash, a lurch forward and we came to a halt.

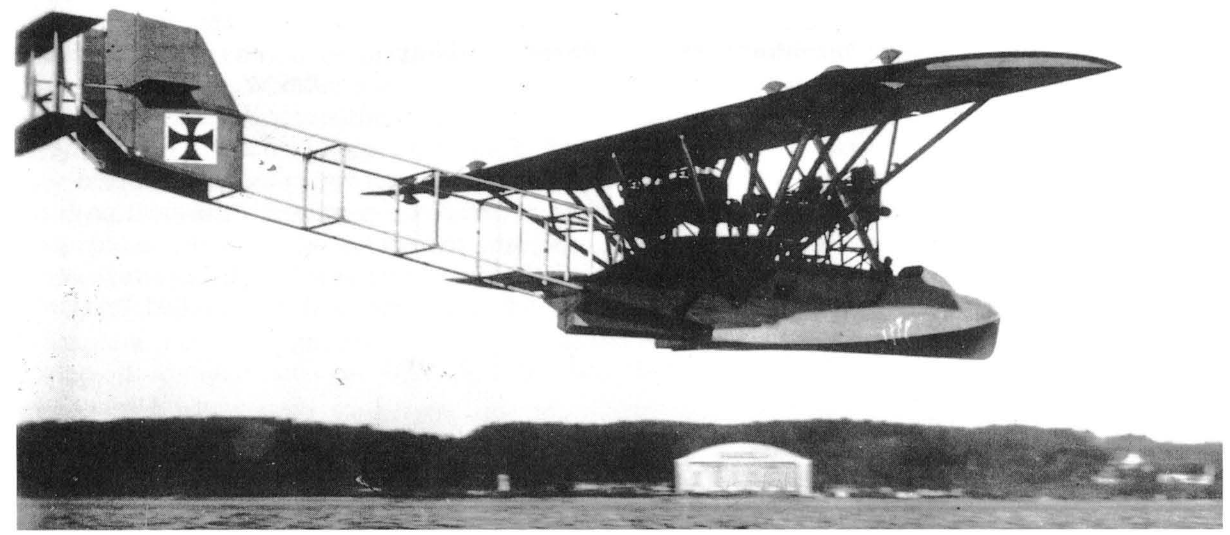
Triller, a Dornier mechanic who also was aboard the Rs.II on its first flight, described the event somewhat differently:

On 30 June 1916 the Rs.II was ready for its maiden flight. Aboard were Schröter (pilot), Schulte-Frohlinde and myself. The aircraft at the time weighed 7045 kg. The first two take-off attempts were made with the angle of incidence set at one degree and two degrees respectively. On the third attempt with the angle of incidence increased to three degrees, the Rs.II rose into the air on its maiden flight at 07.30 hours. Two more flights were made that day.

Three further flights proved the need for further modification. The lattice-girders that held the upper booms were replaced by large-diameter metal tubes to give the tail structure greater rigidity and strength. Also, the area of the central rudder was reduced and fixed fins fitted between the boom ends to improve seaworthiness, changes were made to the hull's planing surface.



The Dornier Rs.II modified to have increased fin and rudder area, and employing tubular tail booms.



The re-built Dornier Rs.II with four engines.

On 17 July 1916 the modified Rs.II was ready to continue its test programme. These tests were not entirely satisfactory. Various incidence settings were tried to improve take-off qualities. In flight the aircraft reacted well to the elevator and rudder but was sluggish in answering to the ailerons. With the starboard engines throttled back no sinking or stalling was observed, even so, in this condition full rudder was insufficient to maintain straight flight. Trouble was experienced with the port transmission, which vibrated regularly, and it was the failure of this that put an end to the first part of the Rs.II story.

Schulte-Frohlinde reported:

At 10 to 12 metres altitude after ½ minute flight duration, the port propeller broke. Mr. Schröter quickly cut the throttle and we found ourselves at once on the water. Since the hull had remained water tight we were in no danger.

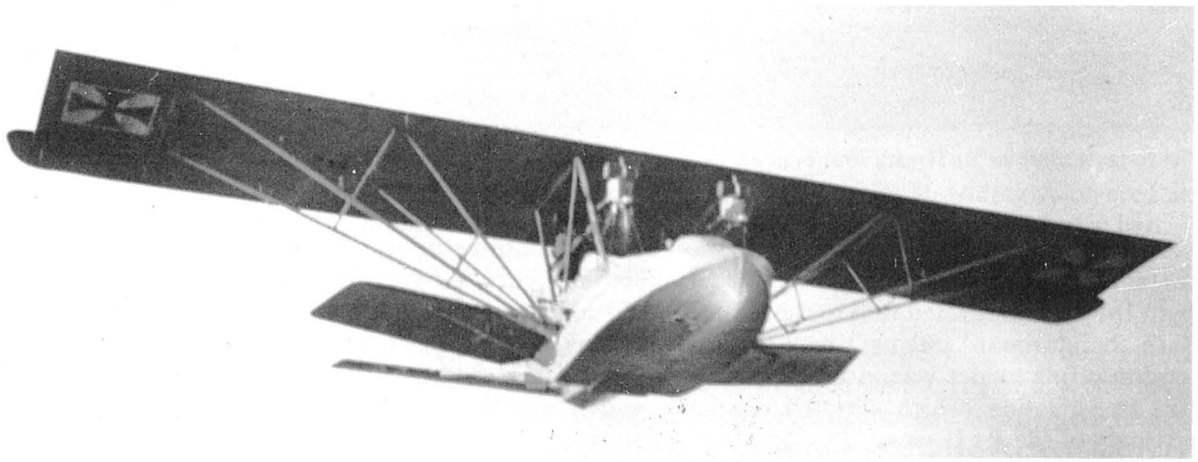
About the incident, Schröter wrote later:

We had drifted and took off again when the middle propeller transmission broke loose and severely damaged the tail boom. We were lucky to land safely in a confusion of torn and bent struts and loose wires.

It was decided to completely rebuild the Rs.II, and the work, which was started in July, was finished on 5 November 1916. On the next day Bruno Schröter, by now the most experienced giant seaplane test pilot, flew the new Rs.II on its maiden flight. The rebuilt Rs.II was virtually a new aircraft, now powered by four engines mounted above the fuselage in a tandem configuration, which Schulte-Frohlinde had thoroughly tested and proven. The propellers were driven through reduction gears and the engines were initially left uncowled. The changed engine location required altering the upper tail boom attachment structure to avoid the propeller arcs. Therefore, the booms were attached to two corners of a triangular tube frame, the third corner of which was joined to a single tube fixed to the centre decking of the hull. The unusual biplane elevator cellule was retained, but a broad fin and rudder of greatly increased area were fitted to improve manoeuvrability on the water. For the same reason, the hull section was refined, and the step moved farther aft to reduce the take-off run, which in spite of these changes still remained too long.

The wing gap was decreased and the wing struts now met the hull about halfway down the sides instead of on top. The only change in the upper wing was to fit aerodynamic balancing surfaces to the ailerons. The lower stub wings were entirely reconstructed with rounded tips and decreased chord. They were placed well aft on the hull and given pronounced dihedral to prevent them from dipping into the water. Tests proved that the Rs.II had adequate stability in wind force 5, although the bottom wings did come in contact with the water under these extreme conditions.

The old experimental Maybach motors in the Rs.II gave no end of trouble during the test programme, much to the irritation of the naval test pilot Lt. Tille. He complained about the galling of pistons and leaking cylinder-heads. The cause of the latter mishap was attributed to the forced slipstream cooling of the uncowled Maybach engines, rather a paradox, for generally the great problem of the Maybach engines was overheating. However, when the engines were cowled and tested again the complaint voiced was that the radiators were too small. In addition, raw material shortages were making themselves felt; spark plugs burned through and valve seats and parts failed regularly, seriously retarding the flight programme.



The Dornier Rs.II undergoing flight trials.

Lt. Tille wrote the following report about the Rs.II after he had flown the machine in November 1916:

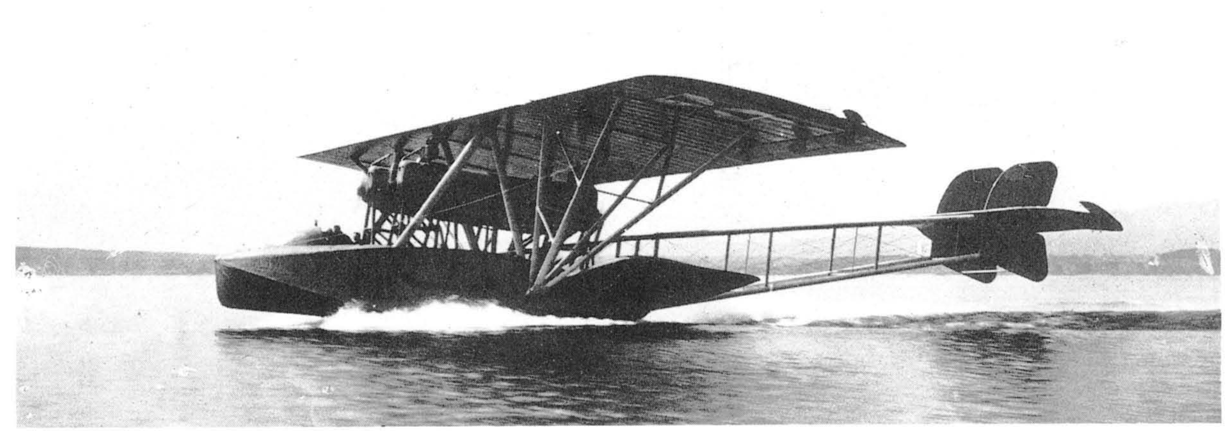
> The flight characteristics, with the exception of a few minor points, are thoroughly satisfactory. The seaworthiness is satisfactory, with exception of the take-off and landing phases. A slight widening of the hull to increase lateral stability is recommended. To insure adequate take-off capability, a complete reconstruction of the hull is absolutely necessary. And last but not least the effect of salt water on duraluminium must be exhaustively investigated.

Lt. Tille was convinced of the future of the R-flying boat when he concluded by saying: "A new flying-boat, built using lessons learned and to be learned, promises the beginning of a development cycle which will extend the flying-boat far beyond the borders of present-day performance characteristics." A prophetic statement indeed, for a flying-boat was, in a few years time, to be the first heavier-than-air machine to cross the Atlantic. On the other hand, with the same optimism shown by Army staff officers at the time, Admiral von Capelle, Commander of the German High Seas Fleet, prematurely expected the arrival of the Rs.II on the coast and he wrote on 28 December 1916: "It is believed an R-flying-boat now under test on Lake Constance will soon come to the coast for further tests. It will then be seen how the R-seaplane can be developed and in what direction." As it turned out, the hopes of the Naval High Command were never fulfilled, for only a single R-seaplane was placed in limited operational service during the war.

Dornier and his staff began to work on their third giant flying-boat, using much of the valuable data gathered from the Rs.II test programme. During May 1917, while practising landings, the Rs.II came down hard on the water, breaking the central boom support. The pilot did not notice that the tail hung by only four cables and attempted to take-off again. The sagging tail forced the Rs.II back on to the water, causing the cables to snap. The lower booms broke and the tail sank to the bottom of Lake Constance. But the hull remained absolutely water-tight during these severe landings and proved to Dornier the soundness of its construction.

By July 1917 the cumbersome tail unit had been replaced by a cleaner design consisting of a single tailplane with finely-formed fins and rudders mounted at the end of each boom. The new boom structure was much stronger and of simpler design. At a later date the wingspan was slightly lengthened to increase lift, the effect being to enclose the ailerons in the wingtip outline.

Up to the summer of 1917 the Rs.II carried out a large number of experimental flights. In the period 23–26 June 1917 it was thoroughly evaluated by the SVK (Seeflugzeugs-Versuchs-Kommando—Seaplane Testing Command). During these, the Rs.II was used to investigate the effect of various engine-off configurations on flight performance. For instance, on Lake Constance it was found



Dornier Rs.II taxying on Lake Constance.

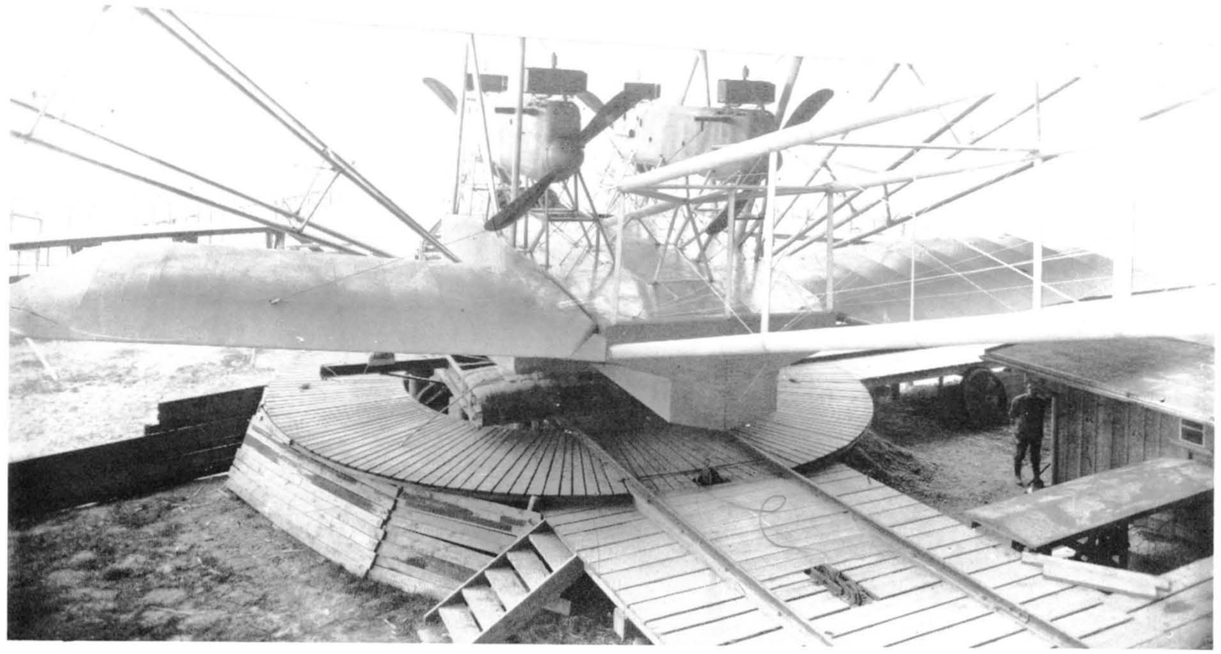
possible to take-off and slowly climb with one forward engine off. It was also definitely proven that the efficiency of the pusher propeller was higher when the forward engine was shut off than the efficiency of the tractor propeller with the rear engine off.

The Rs.II was easy to manoeuvre on the water, and took-off after a 20–30 second run, but in horizontal flight proved to be very tail heavy. Nevertheless, the flight characteristics were considered quite sufficient for long-range reconnaissance missions. The maximum level speed was remarkable. 128 km.h. had been attained over Lake Constance.

By August 1917 preparations were completed to deliver the Rs.II to the Naval seaplane base at Norderney for seaworthiness tests on the North Sea. An emergency supply depot with tools, spares and fuel had been established at Duisberg on the Rhine in case of a forced landing. Essentially, all that remained was for the Rs.II to complete a 6-hour simulated delivery flight over Lake Constance as required by Naval authorities. Plagued by minor but recurring engine failures (especially the valves) and the increasingly deteriorating quality of aviation fuel, the programme dragged on. The fuel was so poor that engine revolutions were often reduced some 50 to 70 r.p.m., which prevented the Rs.II from achieving optimum delivery conditions. With much difficulty sufficient high-grade fuel was collected, and sometime in August 1917 the Rs.II finally took-off on its practice delivery flight. It had been in the air about 2 hours when, at 1100 metres, number 4 engine backfired violently. As Navy mechanic Blume went to investigate he was thrown into a corner of the hull by flying propeller splinters. Engines number 4 and number 1 (which had completely lost its propeller) were shut off and the Rs.II descended safely in a slow glide.

Because of the extensive damage suffered by engines, hull and wings from the volley of propeller fragments, the Dornier company recommended scrapping the Rs.II. Its parts were to be systematically tested and results applied to the design and calculation of new R-planes.

Although built before the Rs.III, the Rs.II was not placed on Naval status until late April 1917, some months after the Rs.III had been ordered. Consequently the Rs.II received a higher Naval number (1433) than the Rs.III (1431).



The Dornier Rs.II on the turntable at Seemoos.

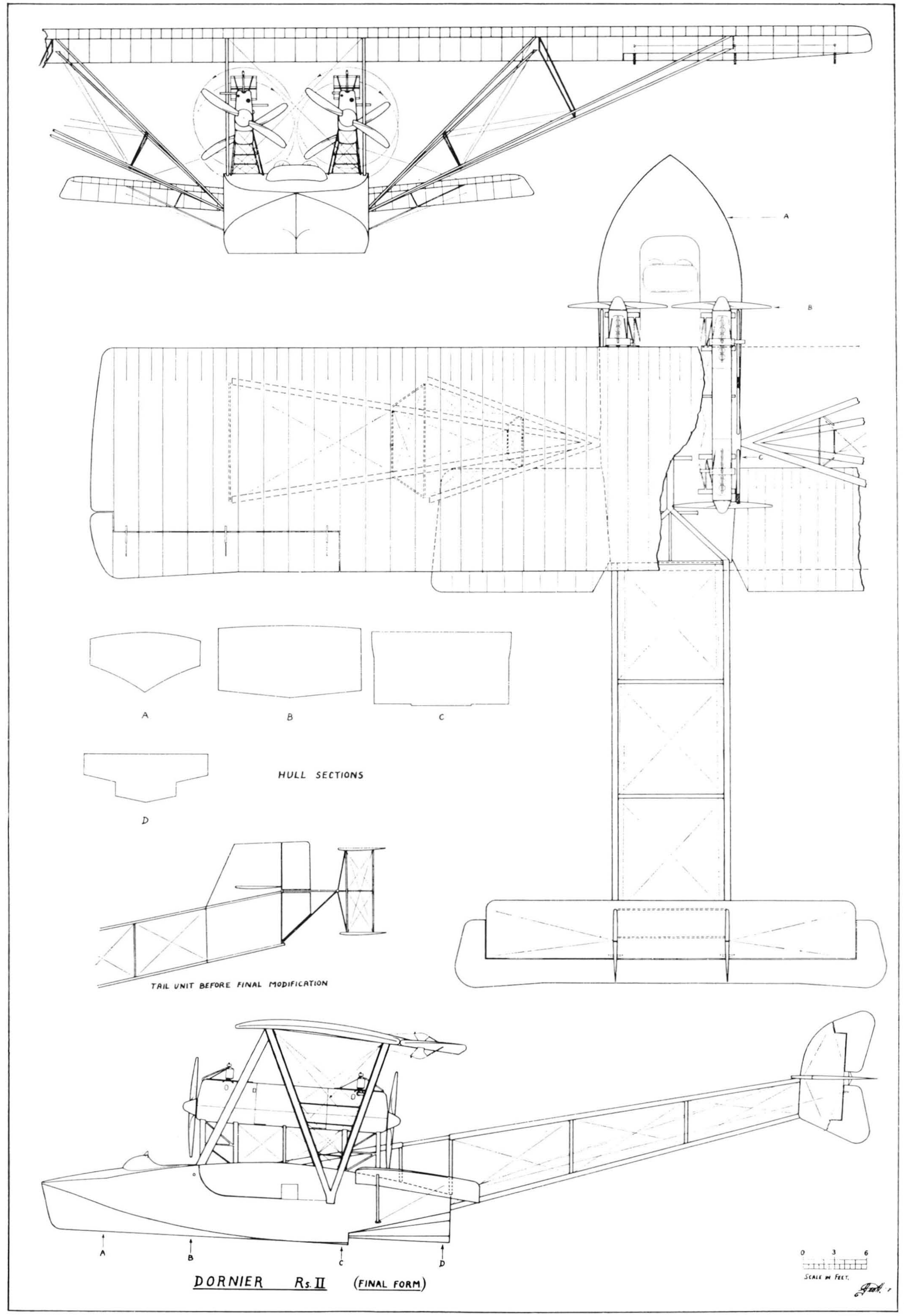
The Dornier Rs.II never did achieve the role intended for it: service tests on the North Sea. Even so, it was an extremely useful test bed. Valuable lessons learned from all its modifications were to have a great influence on Dornier's future work. The broad hull, the tandem engines, the sophisticated metal construction and the adaptability of design became Dornier hallmarks.

Colour Scheme and Markings

The national markings of the Dornier Rs.II consisted of the Patée cross on a square white background. The wingtip markings were rather small, occupying less than a third of the available wing chord. Although the earlier four-engined version had crosses on the tail, no tail markings were carried on the final version of Rs.II.

SPECIFICATIONS

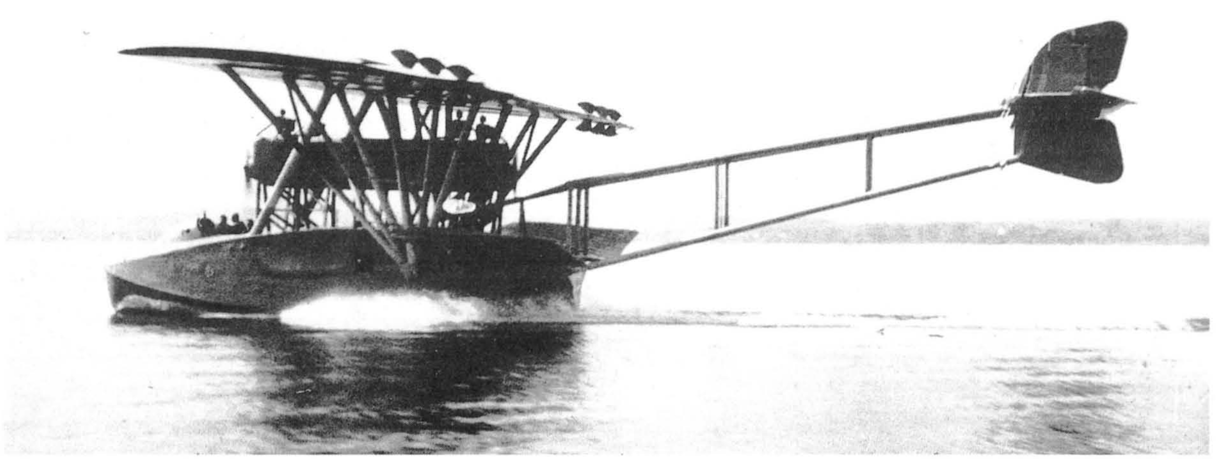
Type:	Dornier Rs.II (first version)
Manufacturer:	Zeppelin-Werke Lindau G.m.b.H., Seemoos, Lake Constance
Engines:	Three 240 h.p. Maybach HS (or Mb.IV) engines
Dimensions:	Span upper, 33·2 m. (108 ft. 11 in.)
	Chord, 6·5 m. (21 ft. 3½ in.)
	Span lower, 15·96 m. (52 ft. 4 in.)
	Chord, 3·58 m. (11 ft. 9 in.)
	Length, 23·88 m. (78 ft. 4 in.)
Areas:	Wing, 257 sq. m. (2765 sq. ft.)



Weights:	Empty, 6475 kg. (14,275 lb.)
	Loaded, 7323 kg. (16,144 lb.)
Performance:	Maximum speed, 100–105 km.h. (62–65 m.p.h.)
Fuel:	2000 litres (440 Imp. Gals.)
Service Use:	None

SPECIFICATIONS

Type:	Dornier Rs.II (second version)
Manufacturer:	Zeppelin-Werke Lindau G.m.b.H., Seemoos, Lake Constance
Engines:	Four 245 h.p. Maybach Mb.IVa engines
Dimensions:	Span upper, 33·2 m. (108 ft. 11 in.)
	Chord, 6·5 m. (21 ft. 3½ in.)
	Span lower, 16·0 m. (52 ft. 6 in.)
	Chord, 3·58 m. (11 ft. 6½ in.)
	Length, 23·88 m. (78 ft. 4¼ in.)
	Height, 7·6 m. (24 ft. 11½ in.)
	Hull length, 11·8 m. (38 ft. 8½ in.)
	Beam, 4·15 m. (13 ft. 7¼ in.)
	Hull height, 2·15 m. (7 ft. ¾ in.)
Areas:	Wing upper, 234·25 sq. m. (2521 sq. ft.)
	Wing lower, 41·75 sq. m. (443 sq. ft.)
	Tailplane, 18·8 sq. m. (202 sq. ft.)
	Elevators, 8·1 sq. m. (87 sq. ft.)
	Rudder, 11·60 sq. m. (125 sq. ft.)
	Ailerons, 14 sq. m. (151 sq. ft.)
Weights:	Empty, 7278 kg. (16,045 lb.)
	Loaded, 9158 kg. (20,190 lb.)
Wing Loading:	33 kg./sq. m. (6·76 lb./sq. ft.)
Performance:	Maximum speed, 128 km.h. (79·5 m.p.h.)
	Climb, 2500 m. (8202 ft.) in 50 mins.
Fuel:	200 litres (440 Imp. Gals.)
Service Use:	None



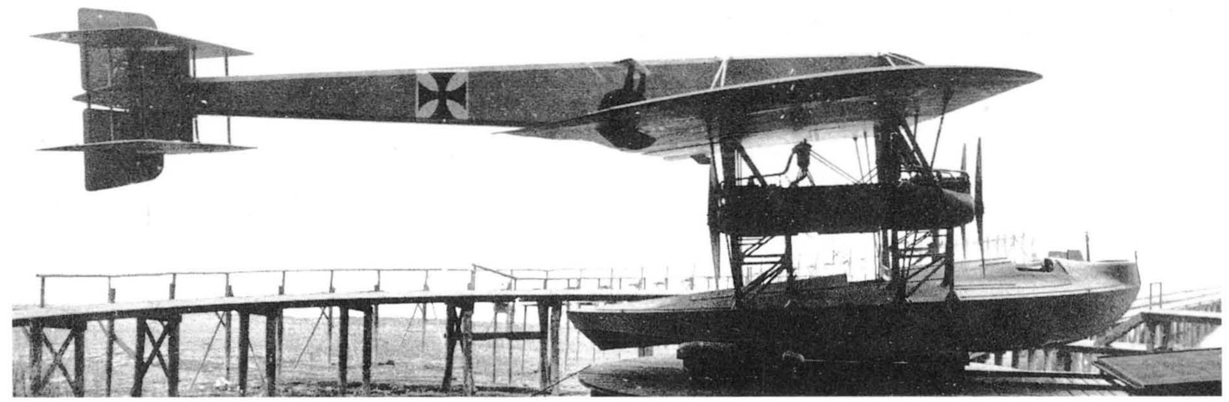
The final form of the Dornier Rs.II flying-boat.

Dornier Rs.III

The third flying-boat to emerge from the Dornier works at Seemoos was externally a completely new design having little in common with its forerunners. The reason for the great difference in appearance was, as Dornier pointed out, to incorporate all the lessons learned from the extensive Rs.II test programme. The Dornier Rs.III was indeed an unusual aircraft, yet every line in its frame had purpose and reason.

The most noticeable change was the square fuselage mounted on top of the wings. This singular configuration was chosen for three reasons: (1) to keep the tail surfaces as far above the water line as possible; (2) to facilitate the mounting of armament above the wings (a Navy requirement); and (3) to provide a centre-section structure to support the wing-bracing cables. It had been decided to replace the wing struts by cables in order to save weight. The high-set fuselage could function as, and thereby replace, the usual centre-section pylon.

The fuselage was constructed of four steel longerons riveted to duraluminium frames. The forward portion of the fuselage was covered with duraluminium sheet and the remainder with fabric. A small



Dornier Rs.III. Early form without fixed tail fin.

soundproof wireless cabin was located in the fuselage nose, followed by a large gun position fitted with mountings for two machine-guns. A small ladder situated between the engine mounts provided access to the raised fuselage through a trap-door in the wing.

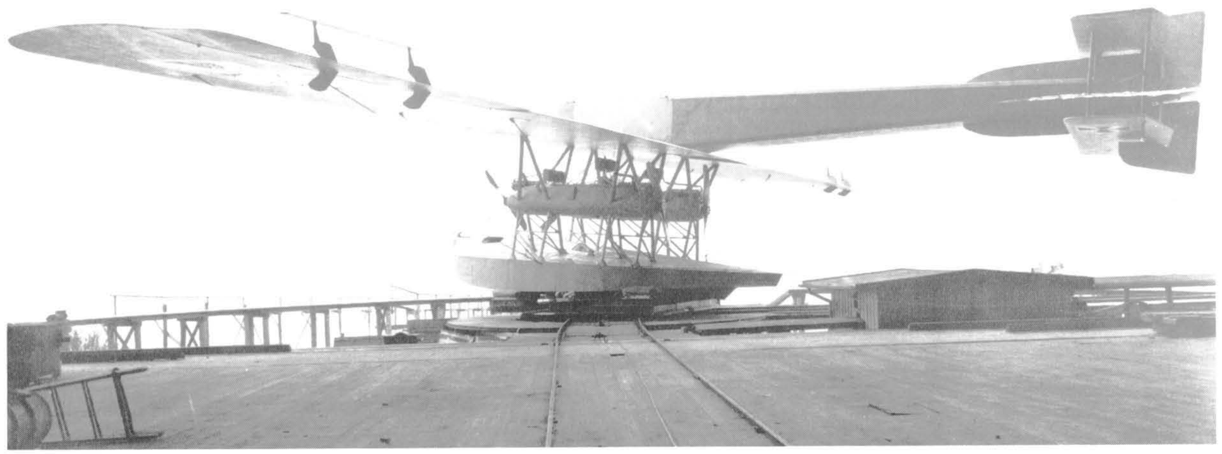
A simple biplane tail unit was mounted at the rear of the fuselage high above the water. Both fixed tailplanes were attached to the fuselage by struts at a mid-gap position and were fitted with unbalanced elevators. Balanced rudders were mounted to a single hinge-post above and below the fuselage. The large fins originally fitted were later reduced to a small fin surface between the tailplanes.

The broad wing, with the characteristic low aspect ratio of the Dornier R-flying boats, was mounted above the engines on short, robust struts. The 6·5 metre chord and the rib section of the Rs.II were retained, but the span was increased about 4 metres. The wing structure as in the Rs.II consisted of three steel spars and duraluminium ribs. The ailerons were hinged to false spars and actuated by two large faired horns, on top of which small balancing aerofoils were mounted.

The four ungeared 245 h.p. Maybach Mb.IVa engines were mounted in tandem between the hull and the wings on a network of heavy struts. The layout of the Rs.III, with its high fuselage and closely grouped engines, is somewhat reminiscent of the Gotha G.I and UWD seaplane designed by Oskar Ursinus in late 1914. Placing the engines close to the flight axis reduced the effect of an asymmetrical engine-off condition on the flight characteristics. It was no doubt planned to cruise the Rs.III on three engines to save fuel on long patrol flights.

The boat-shaped hull, constructed for the first time entirely of duraluminium, was very broad in order to act as a "stable platform" in the water. This feature made it possible to eliminate the lower

stub wing, to which auxiliary floats would have been mounted. The hull was fitted with a nose machine-gun position placed directly in front of the large pilots' cockpit. Another cockpit for the flight mechanic was located in the centre of the hull. From here, the mechanics could regulate the fuel flow from the tanks and climb up to service the engines, if necessary. The mechanic sat between eight 380 litre fuel tanks which were securely fastened to the hull and not suspended by straps as in the Staaken and other R-planes. The fuel was pumped to four 25 litre gravity tanks located in each engine nacelle. The Rs.III design configuration was awarded a German patent (No. 373.171) on 18 December 1917.



The Dornier Rs.III experimentally fitted with extended tail fin.

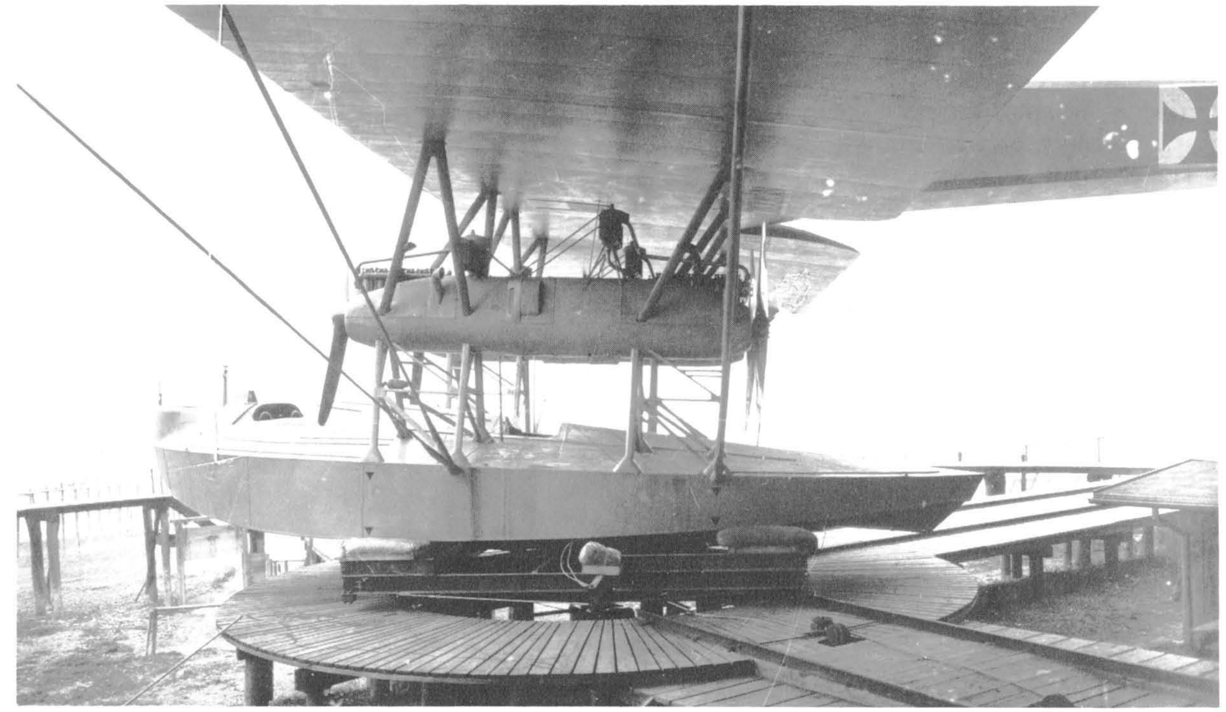
Detail design work on the Rs.III began in February 1917, and construction started in April coinciding with the receipt of a firm German Navy order for one flying-boat (Navy Number 1431) on 25 April 1917. The work proceeded rapidly, and by 21 June Dornier was able to write to the Navy:

> . . . the construction of the Rs.III will be so far advanced by the end of July that the greater number of our workers will be idle. In order to plan ahead, we ask if we can count on building more R-flying-boats for the Navy. We should like to point out that an order for several R-planes based on the Rs.III would give us time to work on advanced designs in less hectic circumstances than has heretofore been the case; in particular, the 2000 h.p. machine of which project drawings have been prepared.

On 31 October 1917 the Rs.III, built in the comparatively short time of seven months, was launched and performed its first taxying tests. Four days later, flown by Navy pilot Oberflugmaat Weiss, it successfully completed its maiden flight. From the beginning only minor problems were encountered. On 27 November the Dornier firm notified the Navy that: "The Rs.III has reached a stage of readiness that, with exception of several modifications, will permit the delivery flight to Norderney to take place in the very near future."

The Navy was anxious to test the Rs.III in the North and Baltic Seas, where water and weather conditions were of a different nature than on Lake Constance. Norderney, a small island in the North Sea, was chosen after a Navy commission had flown along the coast to look for a suitable base. Norderney already was one of the most active seaplane stations on the North Sea. A large hangar for the Rs.III was constructed on the base rather than over the water as at Warnemünde. The Navy constructed a large beaching wagon and a turntable to handle the launching and retrieval of the Rs.III.

While the facilities at Norderney were being completed, preparations were made to fly the Rs.III along



Close-up of the nacelles and hull of the Dornier Rs.III.

the route; Lindau–Rottweil, across the Black Forest to the Rhine, along the Rhine to Duisburg–Münster–Emden–Norderney. Because the flight was to be made within the operational radius of Allied aircraft, fighter cover was to be provided from Rottweil to Duisburg. Furthermore, the Flak batteries along the route had to be notified; the weather reports from stations along the route had to be co-ordinated; and a guide aircraft had to be provided from Cologne to Emden to steer the Rs.III clear of the Dutch border. The extensive arrangements for the delivery flight to Norderney were carried out in great secrecy.

In the meantime, the Rs.III was put through extensive tests by company engineers, pilot Schulte-Frohlinde and Navy pilots Weiss and Hammer. Their flight reports stated:

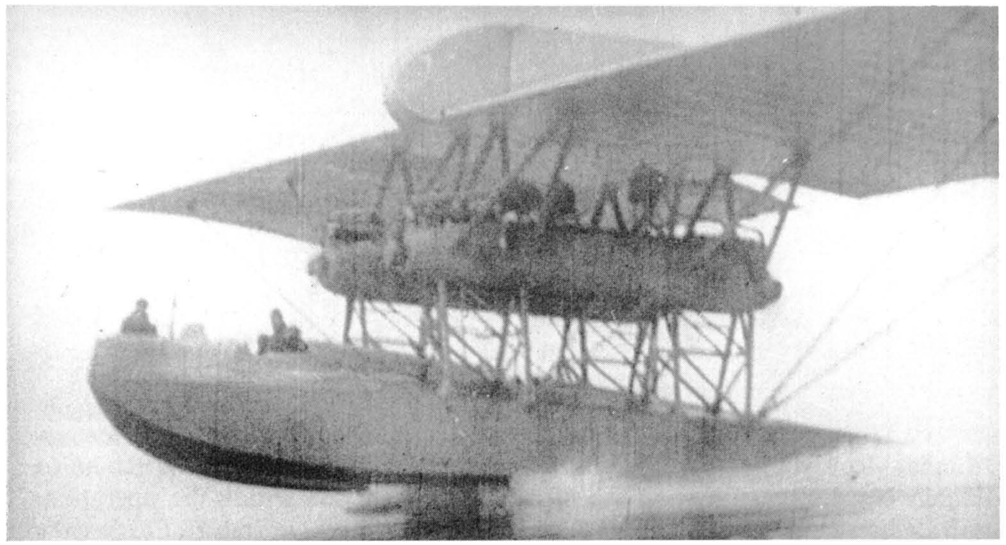
> The take-off tests (numbers 1–4) showed that very light forward pressure on the control column was sufficient to push the nose down and in about 5–10 seconds the aircraft was on its hull-step. It then alighted without effort by pulling back lightly on the controls (30–51 seconds). The foregoing illustrates that the Rs.III has absolutely reliable take-off characteristics . . . when taking-off against the wind in a calm sea only very slight control movements were required. This means that a large steering reserve is available when taking-off in heavy seas. The take-off characteristics are sufficient with the present hull-steps. A further clarification of the improvement of take-off and sea-keeping qualities is only possible after tests on the North Sea.

Regarding the flight characteristics of the Rs.III, another report states:

> As soon as one has become slightly accustomed to the natural oscillations which every R-plane possesses, then the Rs.III is relatively easy to fly. Elevator and rudder controls can be moved hard-over without undue exertion. Similarly, the ailerons are easily actuated up to 40 per cent of their movement. When the load is properly distributed it is possible to fly the aircraft for longer periods of time without using the elevator controls whether with the engines running or in a glide. The flying of sharp turns requires practice. Suddenly throttling the engines will cause the aircraft to pitch up as is the case in all flying-boats.

The Rs.III was flight-tested for three months during which time small modifications were made. By the end of January it was standing-by for the delivery flight, but until 18 February 1918 the flight route was covered with fog. On that day, the weather service reported the first signs of a break in the weather: "Weather situation again stable. Strong gusty winds over the Black Forest and along the coast." Finally, on 19 February, the weather reports were favourable all along the projected route.

The Rs.III was prepared for the flight. The delivery crew, consisting of pilots Triller and Weiss, Schulte-Frohlinde and mechanic Heinzelmann, was weighed, and the take-off weight of the Rs.III was put at 9350 kg. Launching was delayed because an oil drainage plug had pulled out as it was being tightened and fell under the floor of the hangar. Meanwhile a floatplane had flown around the immediate area and signalled that there were no wind gusts.

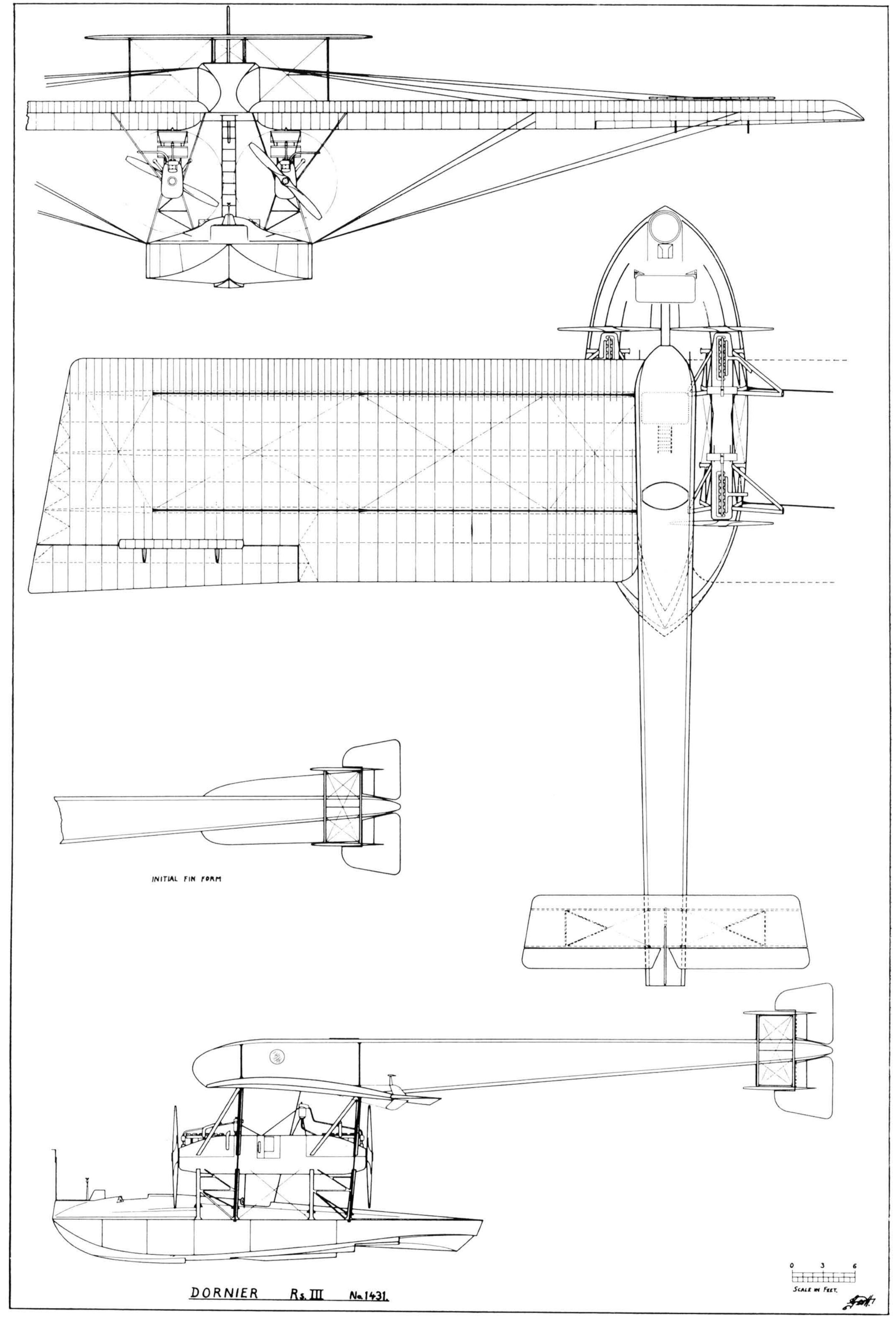


Dornier Rs.III lifting off from Lake Constance.

All was now ready, and at 09.30 hours the Rs.III was launched. The Rs.III taxied in front of the easterly wind for 10 minutes, then turned and took-off at 09.40 hours in a south-east direction. The Rs.III climbed through a thin cloud layer at 1000 metres and crossed the Black Forest at 2200 metres. It was calm, very clear and cold. Near Rottweil the fighter escort attached itself to the flight and remained until Duisburg. The Rhine valley was covered with a mist of varying thickness, and the Rs.III climbed or descended according to the visibility. In the vicinity of Mannheim and in the Ruhr valley visibility was very poor, forcing the Rs.III to fly a more westerly course and to descend to 400 metres until Duisburg. Even so the ground was lost from view for a period of time which would have made an emergency landing impossible.

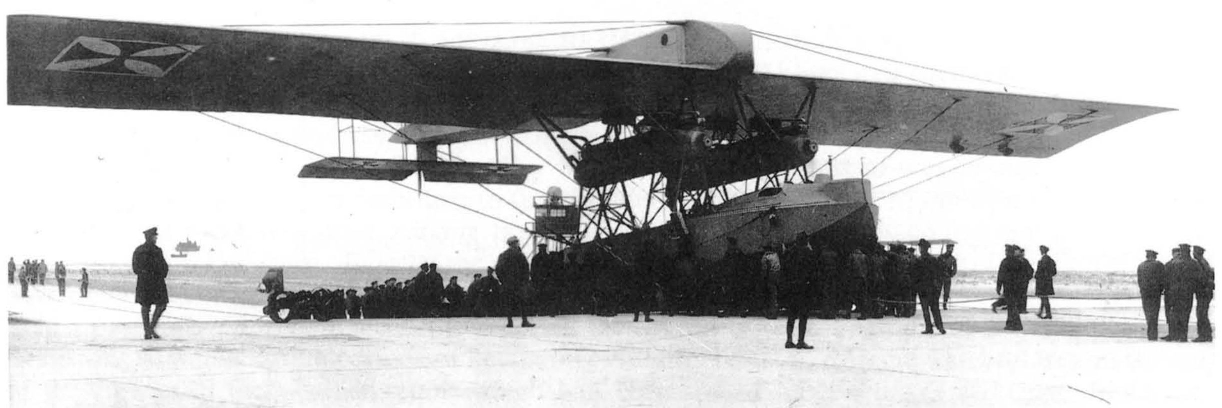
Just past Düsseldorf, the mechanic reported low oil pressure in Engine No. 2. This potentially dangerous situation during periods of fluctuating visibility required extreme watchfulness on the part of the crew, and the weather report which had been spread out on the Goltzheimer Heath was forgotten. The mechanic determined that the oil pressure in the oil filter was sufficient to allow the engine to run, and it did so for the remainder of the flight. Upon landing, it was discovered that a cotter pin on the oil pump had broken.

Duisburg was the location of the emergency supply depot previously established for the planned Rs.II delivery flight. It was strategically located at the three-quarter distance just prior to the portion of the trip on which water landing facilities were not available. The Rs.III dropped some airmail over Duisburg and continued on, climbing to 1500 metres for the remainder of the flight. It reached Münster and flew to Emden along the Ems River, and finally landed at Norderney at 16.45 hours, completing the impressive delivery flight in exactly 7 hours. During the flight the engines were throttled back and the average speed was 120 km.h. Fuel for 2 hours was still left in the tanks when the Rs.III landed.



The Rs.III was thoroughly tested under varying sea and wind conditions for a period of four months. The chief pilot in charge of these tests was Fritz Hammer of the SVK. The machine was accepted by the Navy on 13 June 1918, and it was turned over to the SVK on 27 August 1918 for further Navy tests. The following statements are excerpts from the *Report of the Sea Trials with Flying Boat Marine No. 1431 at Warnemünde.*

> Bringing the flying-boat out of the hangar (for description, see Staaken L chapter) was extraordinarily smooth and easy. The floating pier to which the aircraft was fastened was swung out quickly and safely. Two of the engines were started while the aircraft was still secured to the pier, which permitted the aircraft to cast-off with two engines running. The pier made it possible to communicate between land and aircraft up to the last moment.
>
> The Rs.III could be sailed in a wind velocity of 11–12 m/sec. without using the engines. With the rudders and ailerons fully deflected, the Rs.III can be headed four points from the wind and the machine turned to the side on which the aileron was deflected down. The aircraft can taxi forward using the engines while it is simultaneously blown sideways by the wind. The pilot has complete control by using the throttle for forward motion and the flight controls for sideways motion.
>
> The take-off in *Seegang* 3–4[1] (wave height $\frac{3}{4}$–4 metres, wind force 4–5) occurred without any difficulties. The nose of the aircraft was raised steeply as soon as the throttles were opened, so that the sea ran cleanly underneath the hull. The propellers were completely free of spray. The landing was very soft and agreeable with no unusual occurrences.
>
> The rudder and elevator did not come in contact with the water while taxying directly into the wind, in spite of a heavy pitching motion caused by the waves. In its lowest position the rudder was about 1 metre above the water.
>
> With the wind off the beam and with the seas running against the sides of the hull, the Rs.III behaved very well and the motion was agreeable and calm due to the aircraft's low metacentric height.



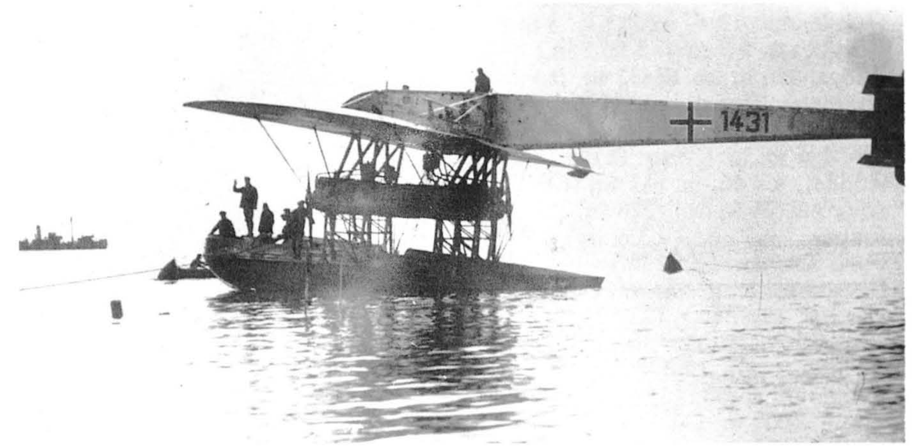
Dornier Rs.III at the Norderney Seaplane Station on 28 August 1918.

The Rs.III was easy to fly. After getting accustomed to the rather sluggish lateral reaction, the aircraft could be flown by any average pilot. On the other hand, take-off and landing required more practice. Engine accessibility was criticized because the strong propeller wash made the mechanic's task of performing small engine repairs extremely difficult if not impossible. Furthermore, it was found that the centre-section wing fabric would part from the ribs due to the propeller wash. Double fabric layers and stitching solved this problem, and in future aircraft the rib spacing was to be reduced.

[1] *Seegang* is a German sea-scale system based on both wind velocity and wave height. Because no direct English comparison has been found, the original German system is retained for clarity.

In conclusion, the report stated that the Rs.III was released for front-line service under test category Class V to the Navy R-plane Command (on 27 October 1918). Pilots Hammer and Niemeyer performed several 10–12 hour evaluation flights from Norderney[1] before the end of the war.

The Rs.III was not immediately destroyed after the war but enjoyed a relatively long post-war life. As late as January 1920 it was to be found on a roster of 100 mine-spotting Naval aircraft still operated by the Germans for clearing mines in the North Sea and Baltic Sea. The Rs.III was destroyed by order of the Allies on 30/31 July 1921, at which time the German Government valued it at one million marks.



Dornier Rs.III with naval identification number and late-1918 insignia at Norderney.

The Dornier Rs.III was the only giant seaplane to achieve active service with the Navy, even if it was only limited operational duty.

The characteristics of the Dornier flying-boat received favourable comment in a contemporary publication:

> The R-seaplane tests proved the superiority of the four-engined monoplane flying-boat over the four-engined twin-float biplane. The Dornier flying-boat was faster and easier to fly, possessed better flight characteristics and had greater in-flight reliability than the Staaken machine. The sea-handling characteristics of the Dornier flying-boat were superior to those of the Staaken float-plane, but which aircraft had better seaworthiness could not be determined before the war's end.

The fact that the Rs.III had such good qualities, that it was built of metal and that it passed its sea trials successfully constituted a notable achievement in those days of wooden aircraft. Its success speaks highly for the technical competence and vision of the men who conceived and built the Rs.III.

Colour Scheme and Markings

Until the late spring of 1918 the Rs.III carried the cross Patée superimposed on a square white background; these crosses were painted on both surfaces of the wing near the tips, on the upper and lower tailplanes at about two-thirds of the span and on the middle of the fuselage. The white square on the wing only utilized half the wing chord. Later a standard narrow Latin cross, that also only spanned half the chord, was carried on the wings. The Latin cross with a large white border was painted on the tailplanes. A U.S. Navy Technical Note stated that the exterior duraluminium surfaces were painted but that the interior was left bright.

[1] The Report of the Aircraft Section of the Allied Naval Armistice Commission states: "The primary function of giant seaplanes is long-range reconnaissance, and that seen at Norderney (Rs.III) was intended for use against the Grand Fleet. It was hoped that reconnaissance as far off as Scapa Flow would be made."

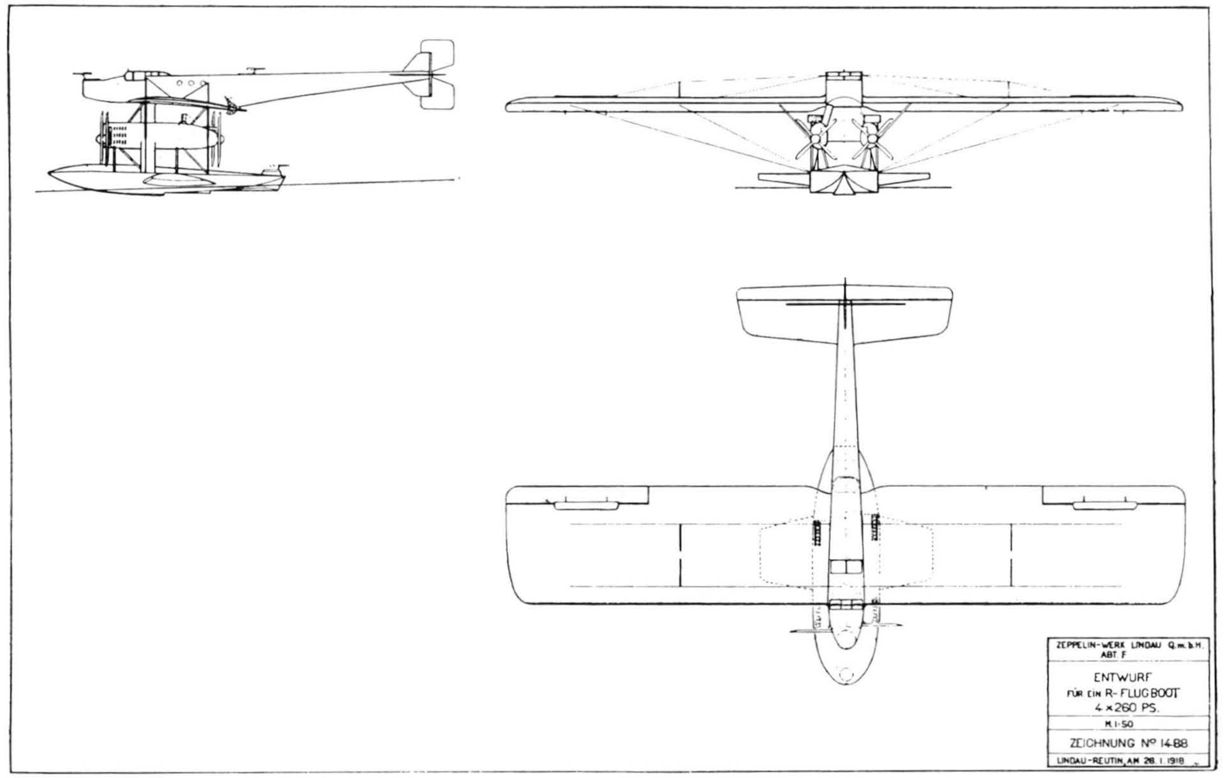
SPECIFICATIONS

Type:	Dornier Rs.III
Manufacturer:	Zeppelin-Werke Lindau G.m.b.H., Seemoos, Lake Constance
Engines:	Four 245 h.p. Maybach, Mb.IVa engines
Dimensions:	Span, 37 m. (121 ft. 4½ in.)
	Chord, 6·5 m. (21 ft. 4 in.)
	Length, 22·75 m. (74 ft. 8 in.)
	Height, 8·2 m. (26 ft. 11 in.)
	Tailspan, 8·4 m. (27 ft. 6½ in.)
	Chord, 2·15 m. (7 ft.)
	Propeller diameter, 3 m. (9 ft. 10 in.)
	Propeller centres, 3·3 m. (10 ft. 10 in.)
	Hull length, 12·57 m. (41 ft. 3 in.)
	Hull beam, 4·7 m. (15 ft. 5 in.)
Areas:	Wings, 226 sq. m. (2432 sq. ft.)
	Tailplane, 23·6 sq. m. (254 sq. ft.)
	Elevators, 10 sq. m. (108 sq. ft.)
	Fin, 1·4 sq. m. (15 sq. ft.)
	Rudder, 4·4 sq. m. (47 sq. ft.)
	Ailerons, 21 sq. m. (226 sq. ft.)
Weights:	Empty, 7865 kg. (17,339 lb.)
	Fuel, 2260 kg. (4982 lb.)
	Disposable load, 545 kg. (1202 lb.)
	Loaded, 10,670 kg. (23,523 lb.)
	Hull, 1580 kg. (3484 lb.)
Wing loading:	46·9 kg./sq. m. (9·6 lb./sq. ft.)
Performance:	Maximum speed, 135 km.h. (83·9 m.p.h.)
	Climb, 1000 m. (3281 ft.) in 15·5 mins.
	2000 m. (6562 ft.) in 35 mins.
	Duration, 10 hrs.
	(*Note:* The duration could be extended to about 12 hours by flying on three engines provided the total weight had been reduced by fuel consumption.)
Fuel:	3140 litres (691 Imp. Gals.)
	Oil, 220 litres (48·4 Imp. Gals.)
Armament:	Provision for one machine-gun in the nose and two machine-guns in top of the fuselage
Service Use:	Norderney, August to November 1918

Dornier Rs.IV

Dornier asked the German Navy for a confirmation of future orders (on 21 June 1917—see Dornier Rs.III chapter) and the Navy replied that it intended to order more aircraft from Dornier, although the contract was not placed until the Rs.III was completed. The letter which the Dornier concern then wrote to the Navy in late July 1917 documents the background of the fourth and final R-flying-boat built by Dornier during the war. The letter ran in part:

> We gratefully acknowledge receipt of your letter of 19 July 1917, from which we happily learn that the Navy is going to award us a contract to build another R-plane. Since we will probably not be mistaken if we assume it is to be a flying-boat, we shall begin to gather the necessary material . . .
>
> In the meantime, we have again thoroughly investigated ways in which the new 1000 h.p. machine (Rs.IV) could be improved over the Rs.III. In particular, we have once more examined whether a biplane or triplane configuration would be an improvement. But we have come to the conclusion that, with respect to weight and aerodynamic characteristics, we cannot expect either of the above configurations to provide any advances over the monoplane. We are presently also investigating if the elimination of the high fuselage in favour of a conventional flying-boat hull will offer any advantages. The weight of the



Factory drawing No. 1488. The first General Arrangement of the Rs.IV.

> machine would not change appreciably. We fear, however, that a hull-type fuselage would have considerably greater twisting due to larger steering-control movements than in the Rs.III. . . .
>
> It remains for us to discuss our standpoint in the matter of engine gearing. It is our opinion that a transition to gearing is premature, and we should like to await the experience of other firms in this regard. . . .
>
> The primary task, as we see it, is to thoroughly work out the details. This attention to detail can only be possible if the configuration of the machine is not greatly changed.

Although preliminary design work was well under way during the middle of 1917, the contract for the Dornier Rs.IV was not awarded until January 1918. At that time two flying-boats, numbered 8801 and 8802, were ordered by the Navy and construction work began at once.

At a meeting between Dornier engineers, Schulte-Frohlinde and Presser on 30 January 1918 a number of design decisions were formulated. Since Staaken experience had shown that the commander preferred the forward machine-gun position during critical moments, it was decided to provide the Rs.IV with a comfortable observation post. Initially it was envisaged to have a raised cabin similar to the Staaken R.52 with a machine-gun ring situated above a glassed-in nose. Two pilots were placed further back in a bulged-out section to obtain good visibility to all sides and provide adequate room in the rather slim fuselage. However, this proposal was discarded in favour of the more conventional raised cabin.

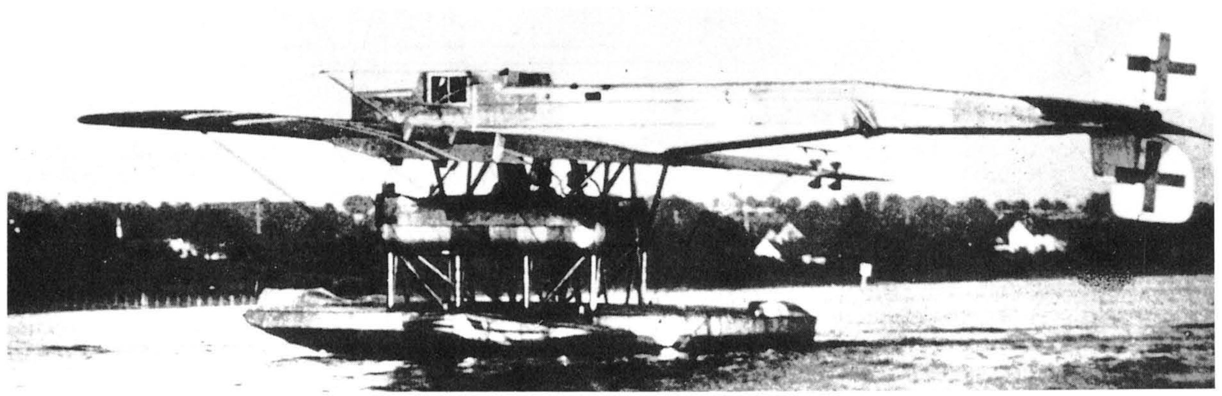
The drawings and photographs show that the Rs.IV retained the basic Rs.III configuration, but with overall design refinements. The appearance of the Rs.IV was more modern, embodying the characteristic rounded and smooth forms typical of all-metal construction. Even wider use was made of stressed-skin construction, a technique Dornier had been investigating on several smaller land biplanes.

The Dornier sponsons are to be seen for the first time on the Rs.IV, a feature which was a hallmark

of Dornier seaplane design for many years. Dornier developed the sponson configuration to reduce the size of the hull and to cut down drag and weight. The sponson, because of width and surface area, increased lateral stability and take-off (planing) performance without undue weight or drag penalty. The beam of the hull was reduced to 3·65 metres from the 4·7 metre beam of the Rs.III hull. The sponsons (which had a span of 8 metres) formed an integral part of the hull structure. As a result, the weight of the Rs.IV was about 600 kg. less than the Rs.III.

The hull was of all-duraluminium riveted stressed-skin construction; it consisted of fourteen bulkheads covered with a thin metal skin reinforced on the outside by inverted U-shaped longerons running the length of the hull and internally strengthened by a series of diagonal frames. A small amount of steel was used for highly-stressed parts. A machine-cannon and machine-gun were located in raised bow and stern hull turrets respectively. A position for two mechanics was located in the centre of the hull between the engines. Surrounding the mechanics' position were ten 300 litre fuel tanks built into the hull which contained a fuel supply sufficient for ten hours flying time.

Owing to the narrower hull, the tandem ungeared engines were set closer together than in the Rs.II and Rs.III. This necessitated staggering the nacelles to provide propeller clearance. The nacelles were broadened to include space for a mechanic's position and oil tanks between the engines.



Dornier Rs.IV after a hard alighting buckled the fuselage, 12 October 1918.

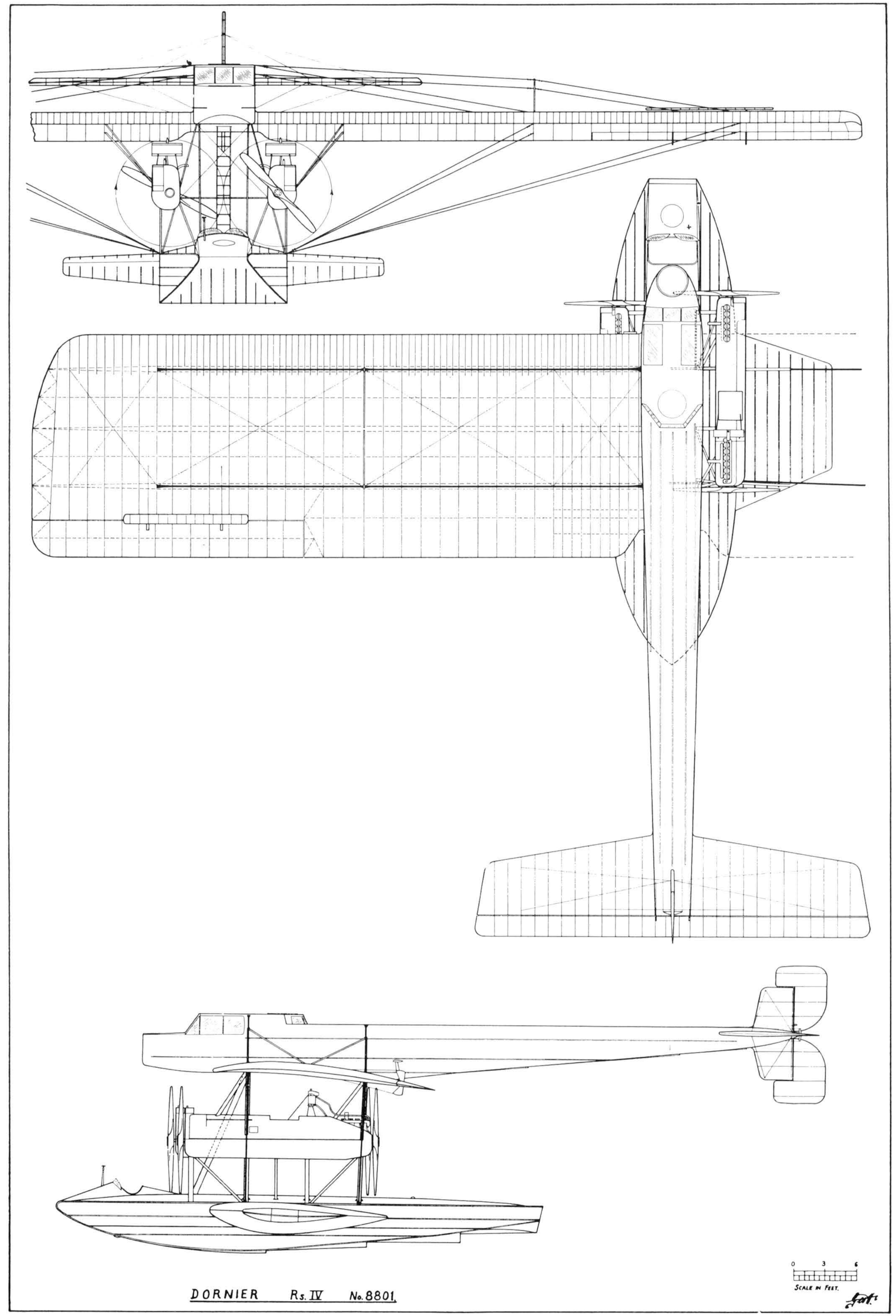
The front engines were fitted with offset nose radiators, while the rear radiators were mounted on brackets above the nacelles.

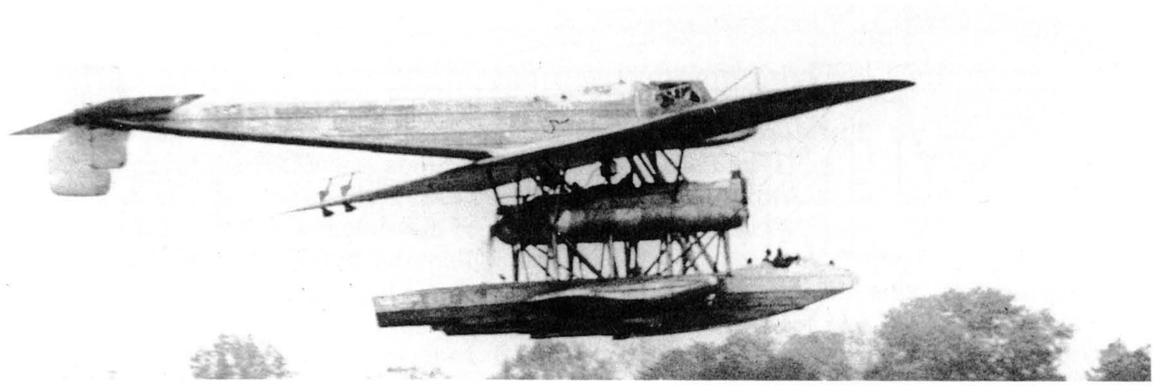
The wing mounting was strengthened by several additional struts, running directly from the wing to the hull. An enclosed ladder shaft connected the starboard nacelle with the upper fuselage; an unusual feature, since connecting ladders in R-planes were generally left open. The shaft was eliminated in the civil version. The all-metal wing retained the same span, area and structural features as the Rs.III wing, but the wingtips were rounded and the cable bracing modified by the addition of king posts at half-span position.

The 60 foot fuselage was a true stressed-skin monocoque structure devoid of all internal cross bracing. Duraluminium skin was riveted directly to the frames with inverted U-shaped reinforcement stringers riveted along the fuselage exterior. The only steel to be found in the fuselage consisted of small corner braces and attachment points where the cables joined the fuselage. The nose of the fuselage contained a machine-gun mount which doubled as the commander's observation post, followed by the pilot's cockpit and a sound-proofed wireless operator's cabin. A dorsal machine-gun position was located just in front of the trailing edge of the wing.

The fuselage terminated in a graceful tail assembly consisting of faired fins and balanced rudders fitted above and below the fuselage. The single tailplane was cable braced and a one-piece elevator ran along the entire length of the tailplane. The tail assembly was built entirely of duraluminium shapes in the usual Dornier fashion.

The Rs.IV made its first flight on 12 October 1918 on Lake Constance piloted by Oberflugmeister Weiss and Schulte-Frohlinde. During a test flight landing the fuselage was badly buckled. Before





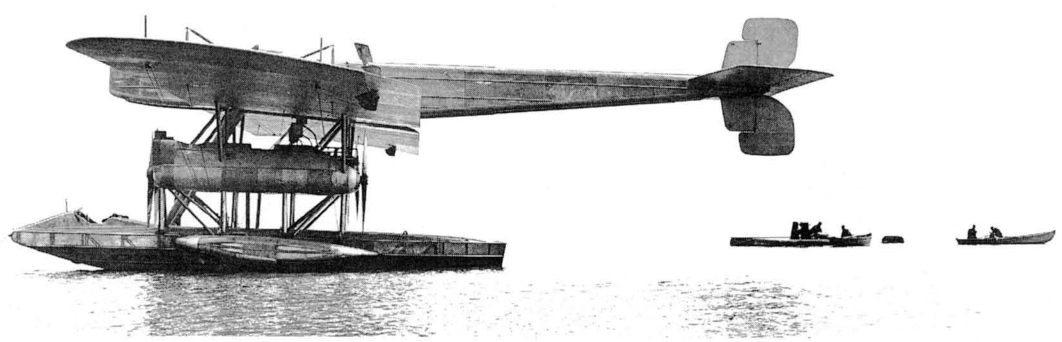
Dornier Rs.IV civil version.

the Rs.IV could be repaired Armistice intervened; consequently, Dornier chose to rebuild the flying-boat into a twenty-passenger civil transport. The pilot's cockpit was shifted to the hull. The fuselage was intended but never fully outfitted as a passenger cabin; machine-gun positions were removed and other small modifications carried out.

In its civil form the Rs.IV underwent extensive tests, and by June 1919 a very thorough and complete evaluation report had been prepared. With one forward engine stopped, it could maintain altitude; but with a rear engine stopped the Rs.IV lost height. The Rs.IV had good flying qualities, was easy to fly, but like the Rs.III somewhat slow to respond to the ailerons. The sea-handling characteristics were good, although the flat forward hull lengthened the take-off run because it pushed large masses of water before lifting on its step.

The tests on the effectiveness and sea-handling properties of the sponsons were not fully completed, since only calm weather flights had been conducted. However, under these conditions no defects were noted. Trials in heavy seas would require the reconstruction of the forward hull. The decreased performance of the Rs.IV as compared to the Rs.III was blamed on the greater drag of the hull, engine nacelles and sponsons. Unfortunately, the Rs.IV had to be scrapped on 17 April 1920 to abide with Allied treaty stipulations.

A French team of experts from the Inter-Allied Control Commission exhaustively studied the Rs.IV after the war, and they were fascinated by the advanced construction techniques applied throughout. Dornier had been uncompromising, for the Rs.IV was built completely from formed strip and built-up shapes, prompting the French to remark that "in the total structure, not a single piece of tubing is employed".



Dornier Rs.IV civil version.

The sponsons received their first exhaustive tests in the post-war Dornier Gs.I, a twin-engined flying-boat originally intended for the German Navy. Throughout the years the sponson and tandem engine layout remained the trade-mark of Dornier aircraft, until quite recent times.

Colour Scheme and Markings

The Dornier Rs.IV military version carried narrow Latin crosses outlined in white spanning the full wingtip chord. Latin crosses were carried on both upper and lower vertical tail surfaces. The upper wing surfaces were covered with naval lozenge patterned fabric. The civil Dornier Rs.IV did not carry any markings. The exterior hull parts were painted with a bituminous mixture.

SPECIFICATIONS

Type:	Dornier Rs.IV
Manufacturer:	Zeppelin-Werke, Lindau G.m.b.H., Seemoos, Lake Constance
Engines:	Four 245 h.p. Maybach Mb.IVa engines
Dimensions:	Span, 37 m. (121 ft. 4½ in.)
	Chord, 6·5 m. (21 ft. 4 in.)
	Length, 22·7 m. (74 ft. 6 in.)
	Height, 8·37 m. (27 ft. 6 in.)
	Propeller diameter, 3·1 m. (10 ft. 2 in.)
	Propeller centres, 3·15 m. (10 ft. 4 in.)
	Hull length, 14·2 m. (46 ft. 6 in.)
	Hull beam, 3·7 m. (12 ft. 1½ in.)
	Sponson width, 8 m. (26 ft. 3 in.)
Areas:	Wings, 226 sq. m. (2432 sq. ft.)
	Tailplane, 21 sq. m. (226 sq. ft.)
	Elevator, 8·8 sq. m. (95 sq. ft.)
	Fins, 2·8 sq. m. (30 sq. ft.)
	Rudder, 4·5 sq. m. (48 sq. ft.)
	Ailerons, 18 sq. m. (193·7 sq. ft.)
Weights:	Empty, 7237 kg. (15,955 lb.)
	Fuel, 1455 kg. (3208 lb.)
	Crew (5), 410 kg. (904 lb.)
	Passengers (20), 1500 kg. (3307 lb.)
	Loaded, 10,600 kg. (23,369 lb.)
	Hull, 1560 kg. (3440 lb.)
Wing Loading:	46·5 kg./sq. m. (9·5 lb./sq. ft.)
Performance:	Maximum speed, 138 km.h. (85·7 m.p.h.)
	Take-off speed, 95 km.h. (59 m.p.h.)
	Landing speed, 90 km.h. (56 m.p.h.)
	Climb, from 400–800 m. (1312–2624 ft.) in 14 mins.
	from 400–1000 m. (1312–3281 ft.) in 22 mins.
	from 400–1400 m. (1312–4593 ft.) in 36·4 mins.
	from 400–2000 m. (1312–6562 ft.) in 53·5 mins.
	Duration, 10 hrs.
Fuel:	3000 litres (660 Imp. Gals.)
Service Use:	None

Dornier Projects

High-powered naval R-seaplanes were mentioned in the German Naval Archives as early as December 1916. At this time a report was filed by Oberleutnant z.S. Mans, who had just returned from an inspection tour to Seemoos, where he examined the Dornier Rs.II. Based on what he saw, Mans doubted that a 1200–2000 h.p. flying-boat could be successfully developed, because it would be unseaworthy and cumbersome. The Mans report stated that a 2000 h.p. seaplane would require at least a 60 metre wingspan and would probably have to be a float-plane.

If Dornier heard these opinions he was not influenced by them, for he pursued the subject of higher-powered seaplanes and actually prepared several design proposals. Perhaps Alfred Colsman, the general manager of the Zeppelin concern, provided a clue to the original purpose behind Dornier's proposals. He wrote that during the war serious consideration had been given to sending gold bullion to Afghanistan by airship. Even though it was intended to sacrifice the airship, the overall risk was too great and the airship plan was dropped. At this point, Colsman approached the Navy with a plan to build a four-engined flying-boat to attempt a flight to the Black Sea. Perhaps the 2400 h.p. Dornier flying-boat project came into being as a result of Colsman's scheme.

At any rate, the projected flying-boat (factory drawing 1575 dated 21 March 1918) was very modern in appearance, and the lines of future Dornier flying-boats followed it closely. The hull and fuselage became one again, as in the Rs.I. Four 600 h.p. Maybach engines were mounted in tandem in nacelles that formed an integral part of the wing. The configuration of placing the propeller in front of the leading edge of the wing had been carefully investigated by Schulte-Frohlinde in 1917. Tests which were a continuation of the tandem-engine experiments of 1916 showed that propeller thrust was not adversely influenced provided the propeller was not mounted too close to the leading edge. The typical broad wing was mounted over the fuselage on pylons and braced by struts leading to the sponsons. The armament was composed of machine-guns or cannon located in bow, dorsal and waist gun positions.

An order was placed by the Navy for two aircraft numbered 8803 and 8804 in June 1918 to be powered by four 600 h.p. Maybach engines.

The 600 h.p. Maybach engine was in its first experimental stages at the time the Navy order was placed. Although one model was completed in 1918/19, it was unlikely that production versions could have been delivered prior to the completion of the projected flying-boat. Perhaps the next design (factory drawing 1580 dated 5 April 1918) reflected this possibility. This project was similar in layout, but was powered by eight 245 h.p. Maybach Mb.IVa engines buried in the hull driving wing-mounted tandem propellers. The length of the fuselage was increased to make room for the eight buried engines, while the elimination of the nacelles made it possible to reduce the overall height of the machine.

The Dornier project drawings Nos. 1575 and 1580 are good representations of the flying-boat ordered by the Navy. According to Dornier sources, the designation of these machines was to have been Rs.V.

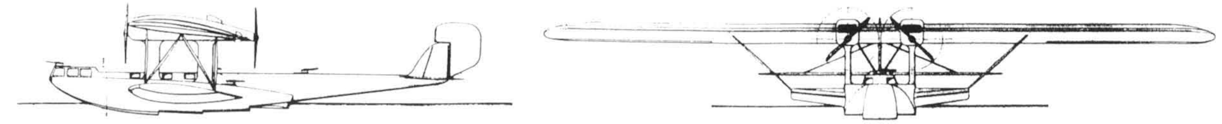
Dornier himself wrote that a machine with eight engines, much larger than the Rs.IV, had been ordered by the Navy, but could not be completed. Another source has claimed that the 2400 h.p. Dornier R-flying-boats were to have a maximum speed of 190 km.h. and carry machine cannon in addition to machine-gun armament. No information is available to indicate if these projects progressed appreciably beyond the design stage.

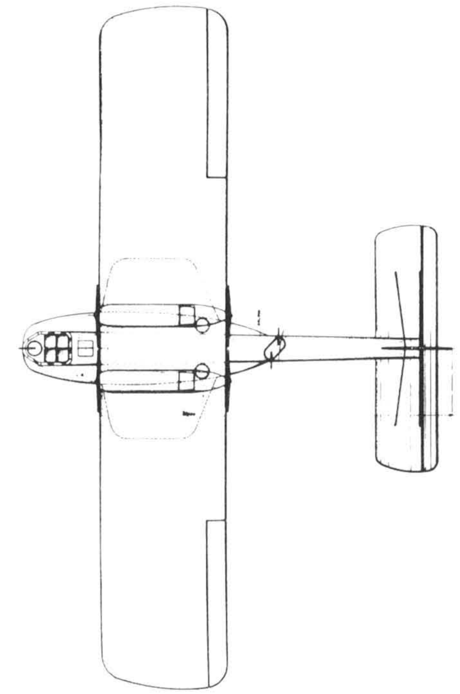
SPECIFICATIONS

Type:	Dornier R-Flying-boat Project (Drawing 1575)
Manufacturer:	Zeppelin-Werke Lindau G.m.b.H., Seemoos, Lake Constance
Engines:	Four 600 h.p. Maybach Mb.VI
Dimensions:	Span, 44 m. (144 ft. 4 in.)
	Length, 28 m. (91 ft. 10 in.)
	Height, 6·5 m. (21 ft. 4 in.)

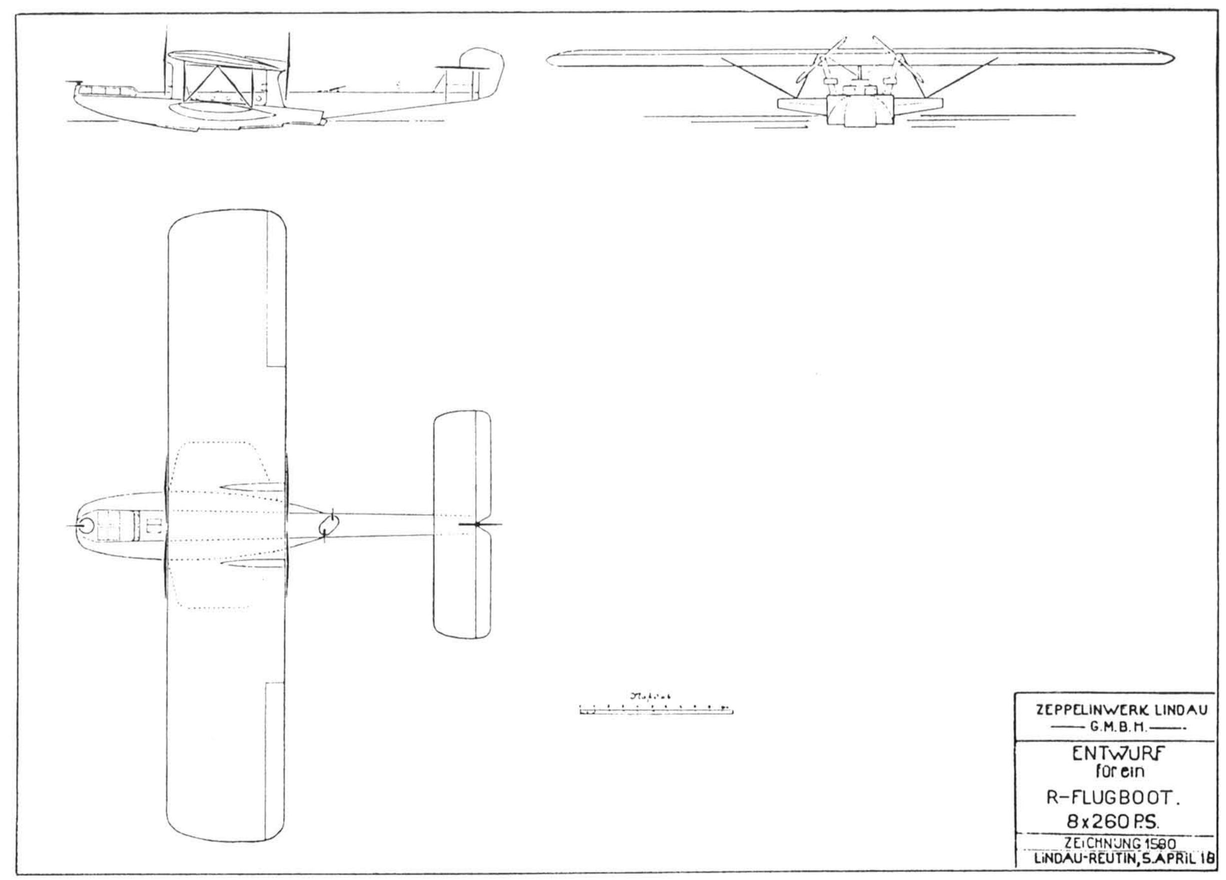
SPECIFICATIONS

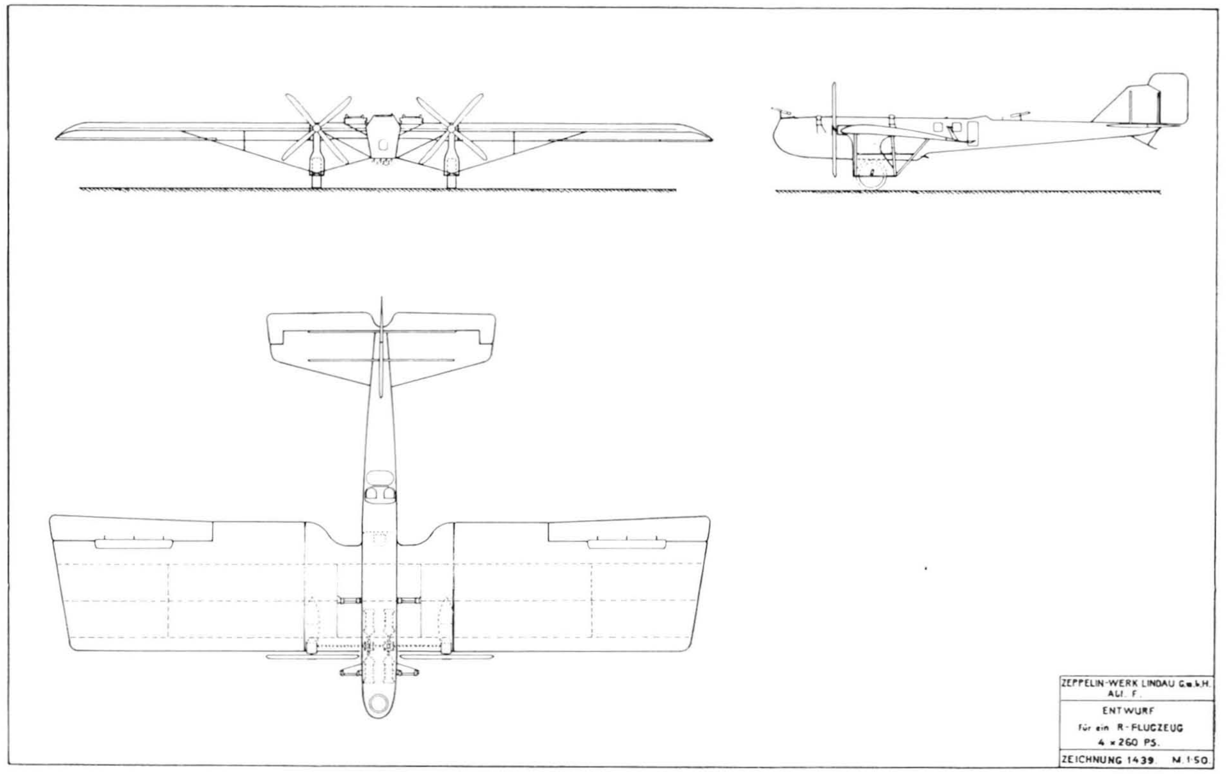
Type:	Dornier R-Flying-boat Project (Drawing 1580)
Manufacturer:	Zeppelin-Werke Lindau G.m.b.H., Seemoos, Lake Constance
Engines:	Eight 245 h.p. Maybach Mb.IVa engines
Dimensions:	Span, 44 m. (144 ft. 4 in.)
	Length, 30 m. (98 ft. 5 in.)
	Height, 5·7 m. (18 ft. 8 in.)





Zeppelin Werk, Lindau. Two design layouts for the projected Dornier Rs.V, marine numbers 8803–8804. Drawing 1575 (top), dated 21 March 1918, shows a flying-boat with four wing-mounted 600 h.p. Maybach engines. In drawing 1580 (bottom), dated 5 April 1918, power is supplied by eight 245 h.p. Maybach engines buried in the hull.





Dornier R.I

Having proven its ability to design and build large monoplanes, the Dornier works was included in the 1917 high-performance, advanced R-plane programme. No doubt a variety of designs were proposed and investigated before the final version was chosen. The Dornier R.I was an all-metal monoplane quite unlike previous Dornier R-plane designs, a very modern aircraft with pleasing lines. Judging from its number, it is believed that the project drawing was prepared in December 1917 or January 1918. The three-spar, cable-braced wing was patterned closely after that of the Dornier Rs.III. Four Maybach engines were located centrally in the fuselage and drove two large propellers through a simple right-angle transmission system. The radiators were mounted close to their respective engines; two on each side of the nose well clear of the fuselage and two over the middle wing spar. A ventral machine-gun was located beneath the trailing edge cut-out of the wing, free of interference from the landing gear. The pilot's cockpit was situated well aft in front of a large turret intended for a 20 mm. cannon. The bombs were carried internally (and possibly also externally) in a bomb-bay underneath and aft of the engines. The streamlined landing gear housing served not only to reduce drag but also as a support structure for the wing bracing cables.

In an internal Idflieg status report for September 1918 we learn that: "The construction of the Dornier R.I has been halted because only Navy aircraft are to be built at Lindau in the future. In addition, the new Staaken project[1] incorporating all the latest experiences, is a further developed succession of the Dornier R.I."

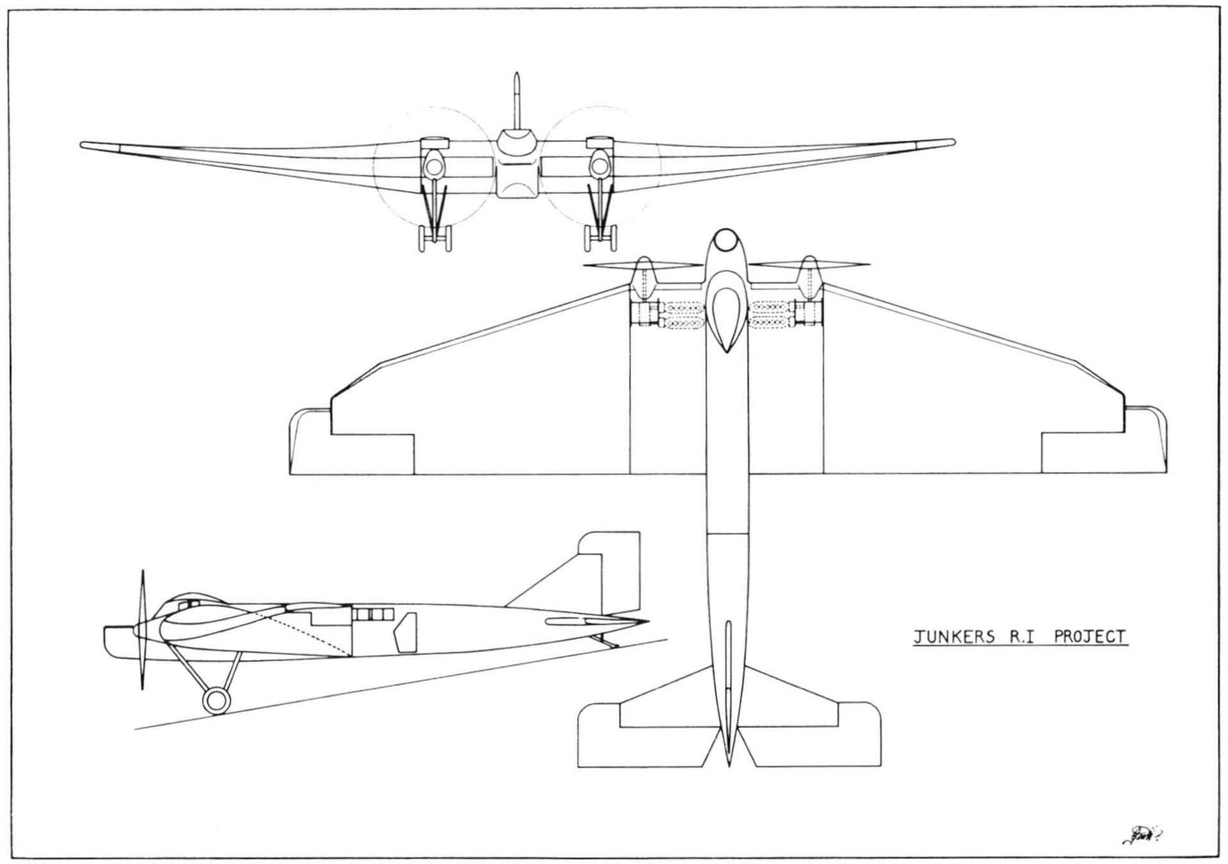
The R.I concept stayed with Dornier for a long time, and the similarity between it and the Do F of 1931 and its followers (Do 11, Do 13, Do 23) is truly remarkable.

[1] See Staaken E. 4/20 chapter.

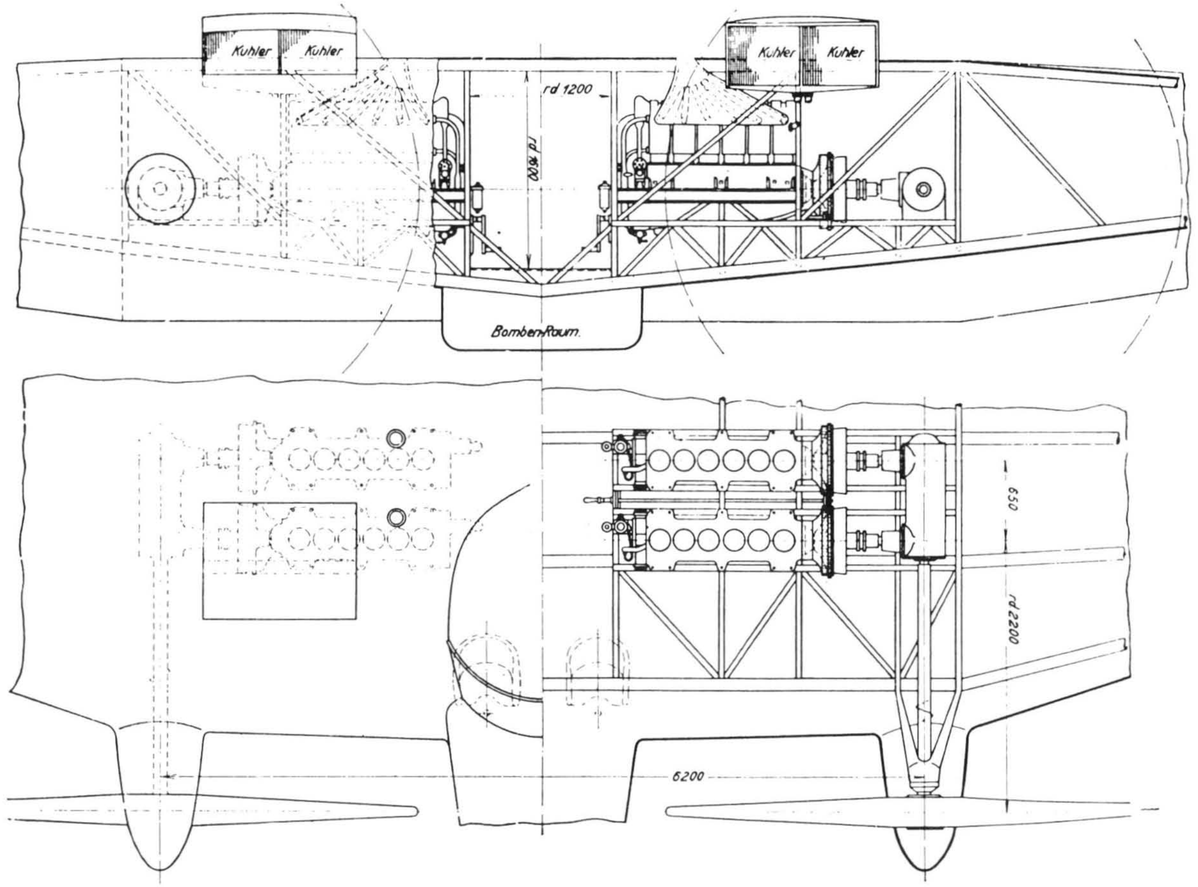
Junkers R.I

During 1917 plans were made to develop a series of high-performance R-planes capable of executing long-range daylight reconnaissance and bombing missions. The design of these aircraft represented a large step forward, and new construction techniques had to be developed to utilize the latest aerodynamic, structural and material advances. The projected aircraft were to be all-metal monoplanes with engines buried but still accessible in a thick cantilever wing. Contracts to build such aircraft were awarded to Junkers, Staaken, AEG and Dornier. Junkers, of course, was a pioneer and leader in all-metal aircraft construction and possessed ample experience to embark on the new task. The firm Junker & Co. had been founded by Professor Hugo Junkers, a brilliant, resourceful and prolific engineer. During his lifetime Junkers was awarded more than 1000 patents in varied fields, including all-wing aircraft, opposed-piston engines (basis for the Junkers Jumo engines), calorimeters, fin-type heat exchangers, water brakes and a new concept for heating water with gas. Junkers started his firm to manufacture gas water heater-bathtub combinations and was extremely successful in this effort.

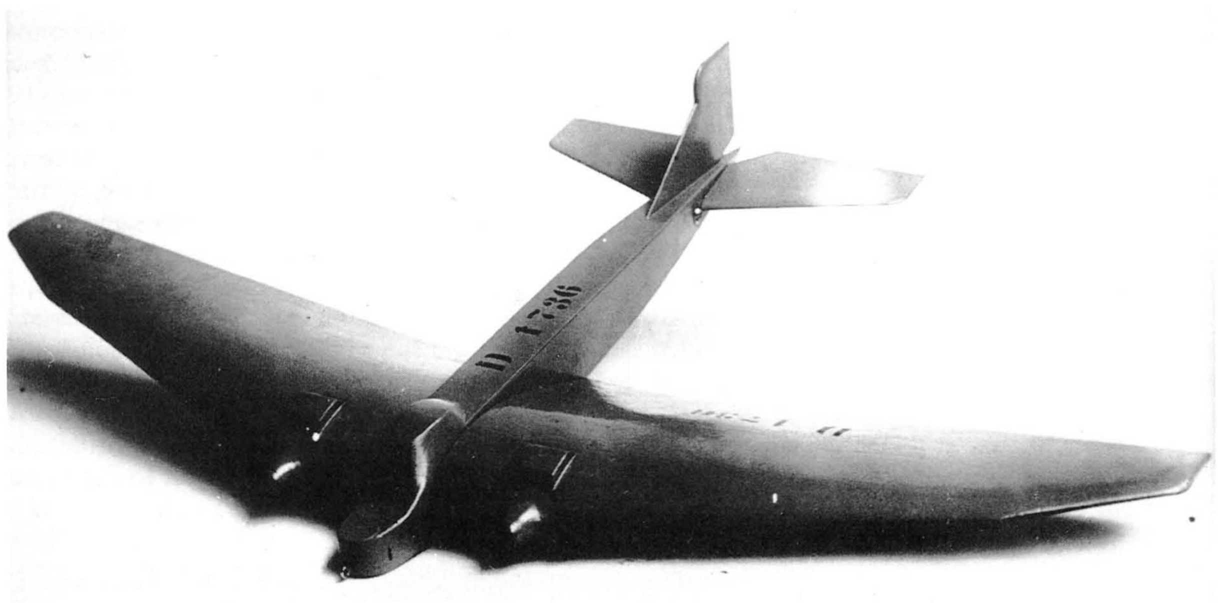
Junkers' initial contact with aircraft came when at the age of fifty he assisted Professor Reissner in designing his *Ente* monoplane. As a result of his experiences, Junkers received the famous patent for the all-wing aeroplane, and in 1912 he left his teaching post at the Technische Hochschule in Aachen to apply his talents to aerodynamic studies. Royalties obtained from licensing his many patents enabled him to build a small wind-tunnel and spend full time in research. When the war broke out he decided to put his theories to practice and systematically developed the Junkers J.1, which was built wholly from 0·1 mm. thick sheet steel and featured the thick wing which was to become a Junkers trade-mark. Several other Junkers types were built before the R-plane contract was placed by Idflieg for two R-planes on 17 November 1917.



JUNKERS R.I PROJECT



Junkers R.I. Engine and power transmission arrangement.



Wooden model of the Junkers R.I used for wind-tunnel tests.

As expected, the Junkers R.I was evolved through a series of intensive structural and wind-tunnel investigations and was possibly the only R-plane that had a wind-tunnel pedigree. The design department had prepared several layouts, the first a monoplane with a 35 metre wingspan (27 March 1917) and the second a monoplane with twin rudders and a wingspan of 38·5 metres (probably middle 1918).

The 35 metre version is generally referred to as the R.I numbered R.57/17 and R.58/17, although as design and wind-tunnel studies progressed the final version may have been more like the 38·5 metre project. The R.I (35 metre version) was characterized by a typical thick Junkers wing consisting of three sections; a centre section integral with the fuselage and two sharply swept-back removable outer sections. The 1·6 metre thick centre panel continued out just beyond the propeller shafts and enabled a mechanic to service the four 260 h.p Mercedes D.IVa engines buried in the wings. The engines were mounted side by side at right angles to the line of flight, and each pair drove a propeller through a clutch and right-angle bevel gear-box. Each bank of engines was equipped with two low-drag Junkers adjustable nozzle radiators placed in the slipstream along the upper wing contour. A 1000 litre fuel tank was mounted slightly behind each engine pair near the centre of gravity.

The wing was different from all other R-planes in that it had no actual wing spars. Rather, the wing spar and rib section was formed by a lattice-work of diagonal metal tubes to which the corrugated duraluminium skin was riveted. This method of wing construction has high torsional stiffness for relatively light weight and provides superior resistance against gunfire, but it is more expensive to produce than wings constructed by conventional techniques.

The slim, square fuselage was constructed from welded steel tubing covered with corrugated skin. A most noticeable feature was the oversize cockpit canopy for the two pilots, which, judging from its size, was also the aircraft commander/navigator's position. A long flat bomb bay capable of holding a 1500 kg. bomb load was located underneath the fuselage. Defensive armament consisted of seven machine-guns and cannon; one was placed in a conventional nose turret; two were located on either side of the fuselage a few feet behind the trailing edge of the wing; two were mounted in the upper wing surface above the engine gangway, and two protruded from beneath the wing outboard of the landing gear. The reason for the heavy defensive armament was that this project was intended to participate in daylight raids when chances of interception were greater.

The tail surfaces, although aerodynamically balanced, were to be fitted with servo-motors to lessen the control forces but still transmit the "feel" of the controls to the pilots.

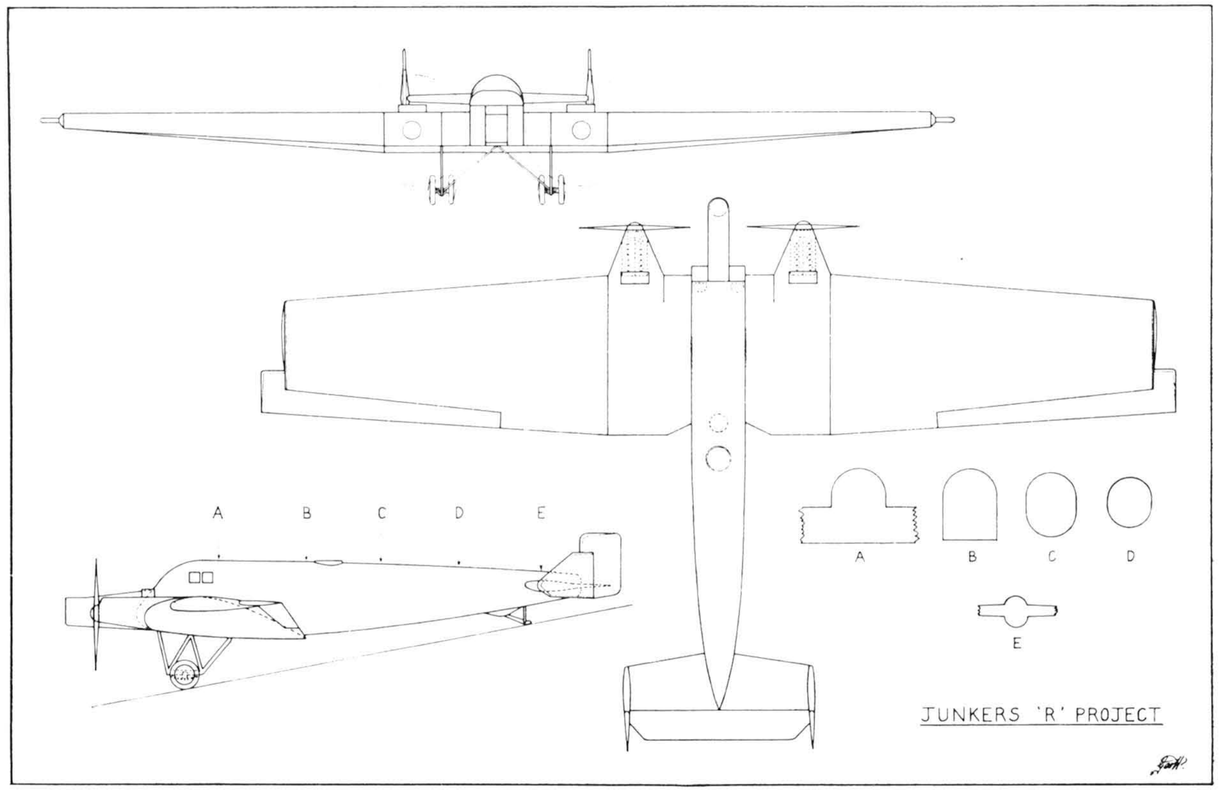
The final design for the landing gear had not been prepared when Junkers ceased work on the R.I at the end of the war. Initial drawings show it as a simple triangular structure supporting twin-wheels. A wind-tunnel model of the R.I minus its undercarriage was tested during July 1917.

Towards the end of 1917 Junkers and Fokker formed the Junkers–Fokker Werke A.G. to build all-metal aircraft. This merger was forced upon Junkers by the military authorities. They felt that Junkers, unlike Fokker, lacked mass-production experience, nor was he a pilot, an asset which counted highly in those days. But the two men had completely different characters and goals. Fokker was interested in wooden construction and could build a new type from scratch in a few weeks, whereas Junkers was an ardent investigator, thoroughly testing each concept before incorporating it in a design. New capital and personnel were brought into the Junkers–Fokker Werke, and the production of the Junkers J.I ground-attack biplane continued more or less automatically. But neither Junkers nor Fokker were greatly enthused by the forced merger, and within a short time each withdrew to his own sphere of activities. Junkers still controlled his heating-apparatus plant, in which he continued his all-metal aircraft developments, culminating in the D.I (J.9), Cl.I (J.10) and Cls.I (J.11). The construction of parts for the R.I began in the Junkers & Co. heating-apparatus plant, where they were found by the Inter-Allied Control Commission inspection team in 1919.

On the 15 March 1918 a list of projected delivery dates issued by Idflieg showed that it expected delivery of the first Junkers R.57 by June 1918, and the second, R.58, by August 1918. As it turned out, the Idflieg projections were over-optimistic, for the R.I was never completed and the various parts which had been assembled had to be destroyed after the Armistice.

The second Junkers R-plane project (38·5 metre span) differed greatly from the first, although the thick wing section was retained. The fuselage height was increased to 3·6 metres, a size which one is at a loss to explain. It was no longer square, but had an oval tail section and featured an extended

nose fitted with a machine-gun turret. The pilots' seats were widely separated; their field of vision was restricted by the high fuselage, engine nacelles and long nose. To simplify the transmission gearing, the right-angle gear-box was eliminated and the engines were mounted in nacelles extending from the wing. Each nacelle contained two engines placed along the flight axis and coupled to drive a single propeller. The radiators were placed above the wing as in the first project. The twin rudders were mounted in the slipstream of the propellers.



Hand in hand with the Dornier and Staaken R-monoplanes, the Junkers R.I provided a startling example of the advanced types of bomber aircraft the Germans were planning to place into service should the war have continued. The modern construction techniques embodied in the all-metal Junkers R.I pay tribute to a great pioneer of aviation and his insistence that new concepts should spring forth from the well of research.

SPECIFICATIONS

Type:	Junkers R.I. (35 metre version)
Manufacturer:	Junkers–Fokker Werke A.G., Dessau
Engines:	Four 260 h.p. Mercedes D.IVa engines
Dimensions:	Span, 35 m. (114 ft. 10 in.)
	Length, 22·3 m. (73 ft. 2 in.)
	Height, 9 m. (29 ft. 6 in.)
	Tailspan, 12 m. (39 ft. 4 in.)
	Propeller diameter, 5 m. (16 ft. 5 in.)
Areas:	Wings, 200 sq. m. (2152 sq. ft.)

Weights (Est.):	Wings and fuselage,	2000 kg.
	Undercarriage and tailskid,	450 kg.
	Tail assembly,	200 kg.
	Engines, exhaust pipes, radiators, water,	2000 kg.
	Fuel and oil tanks,	210 kg.
	Propellers, gears, clutches and drive shafts,	750 kg.
	Engine accessories,	150 kg.
	Fuselage installations (machine-guns and cannon bomb racks, etc.),	240 kg.
	Empty,	6000 kg. (13,230 lb.)
	Fuel,	1300 kg. (2867 lb.)
	Bomb load,	1500 kg. (3307 lb.)
	Crew and remainder	1200 kg. (2646 lb.)
	Loaded,	10,000 kg. (22,050 lb.)
Performance (Est.):[1]	Maximum speed, 180 km.h. (112 m.p.h.)	
	Climb, 1000 m. (3281 ft.) in 4·6 mins.	
	2000 m. (6562 ft.) in 10·8 mins.	
	3000 m. (9843 ft.) in 19 mins.	
	4000 m. (13,124 ft.) in 33 mins.	
	5000 m. (16,405 ft.) in 76 mins.	
	Ceiling, 5200 m. (17,061 ft.)	

SPECIFICATIONS

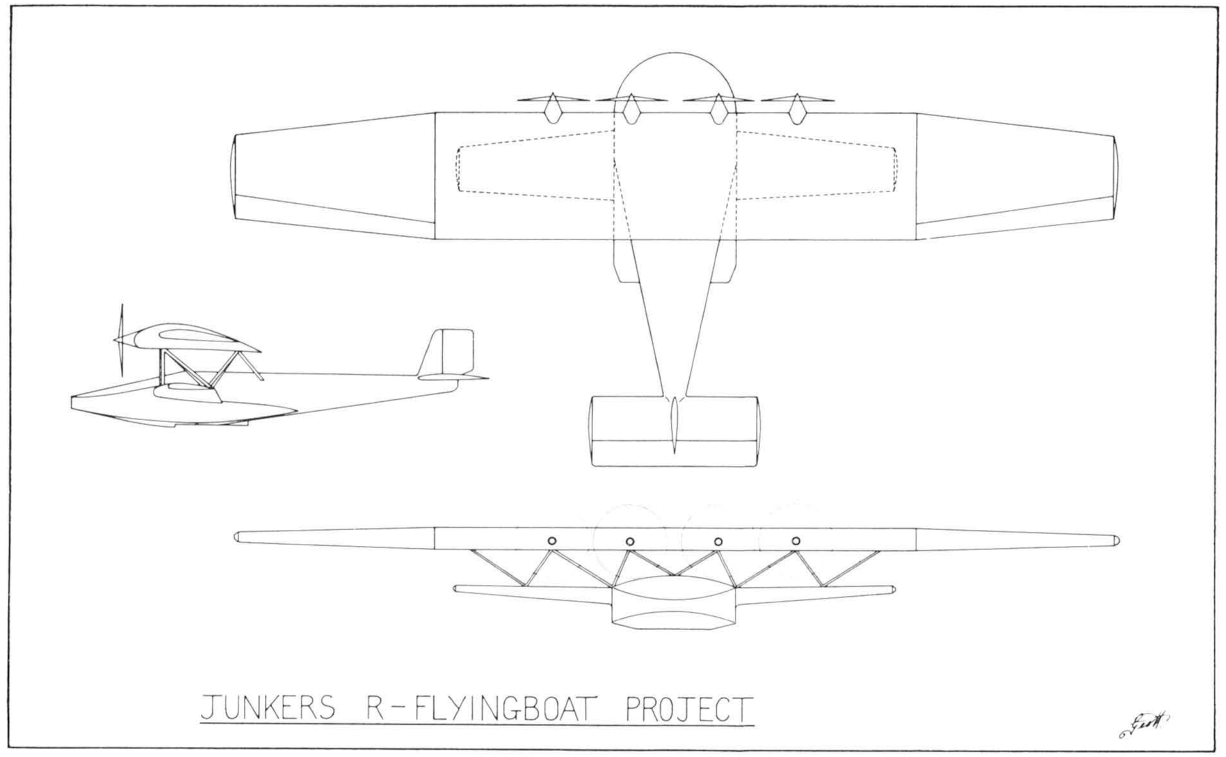
Type:	Junkers R (38·5 metre version)
Manufacturer:	Junkers–Fokker Werke A.G., Dessau
Engines:	Four 260 h.p. Mercedes D.IVa engines
Dimensions:	Span, 38·5 m. (126 ft. 3½ in.)
	Chord, 7 m. (22 ft. 11½ in.)
	Length, 24 m. (78 ft. 9 in.)
	Height, 6·5 m. (21 ft. 4 in.)
	Tailspan, 8 m. (26 ft. 3 in.)
	Wheel track, 4·6 m. (15 ft. 1 in.)
	Propeller centres, 7 m. (22 ft. 11½ in.)
	Maximum fuselage depth, 3·2 m. (10 ft. 6 in.)
	Maximum fuselage width, 2·2 m. (7 ft. 2½ in.)
Weights:	Unknown
Performance:	Unknown

Junkers R-Flying-boat Project

The realization of practical all-metal construction techniques greatly expanded the horizons of the aircraft designer. No longer fettered by the structural limitations of wood, the designer could begin to think in terms of size in a way which would have met with ridicule a few years earlier.

In June 1918 Junkers proposed an all-metal R-flying-boat with the prodigious wingspan of 80 metres (262·5 feet). The flying-boat was to be powered by four 1000 h.p. Junkers engines, a development based on the experimental Junkers Fo.2 opposed-piston engine of 1916, the forerunner of the rugged Junkers diesel aircraft engines of later years. The R-flying-boat and 1000 h.p. engine remained on the drawing board, but their conception was a true measure of things to come. Junkers continued to design large aircraft in the post-war years; for example one behemoth proposed in 1921 had a wingspan of 110 metres. However, it was not until 1928 that the Junkers organization was able to construct its first really large aircraft, the 44 metre wingspan, all-metal G.38.

[1] Calculated with loaded weight at 8500 kg.

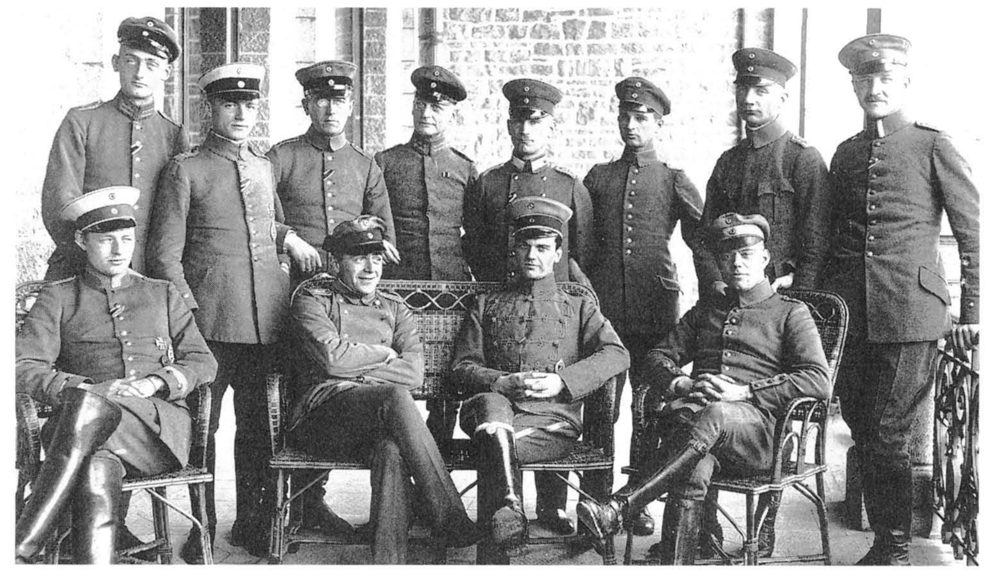


SPECIFICATIONS

Type:	Junkers R-Flying-boat Project
Manufacturer:	Junkers–Fokker Werke A.G., Dessau
Engines:	Four 1000 h.p. Junkers Diesel engines
Dimensions:	Span, 80 m. (262 ft. 5½ in.)
	Chord, 12 m. (39 ft. 4½ in.)
	Wing depth, 2·4 m. (7 ft. 10 in.)
	Length, 38 m. (124 ft. 8 in.)
	Height, 9 m. (29 ft. 6 in.)
	Tailspan, 12 m. (39 ft. 4½ in.)
Areas:	Wing, 1000 sq. m. (10,760 sq. ft.)
Weight:	Loaded, 48,000 kg. (105,840 lb.)
Wing Loading:	48 kg./sq. m. (9·8 lb./sq. ft.)

From left to right: Hptm. George Krupp, commanding officer of Rfa 501; Werkmeister Grütz; visiting Turkish officer Ltn. Saim Bey; Fldw. Kruse; Oblt. Max Borchers on the Porubanok airfield in 1916;

Hauptmann Richard von Bentivegni, commanding officer of Rfa 501 at Scheldewindeke, 1918.

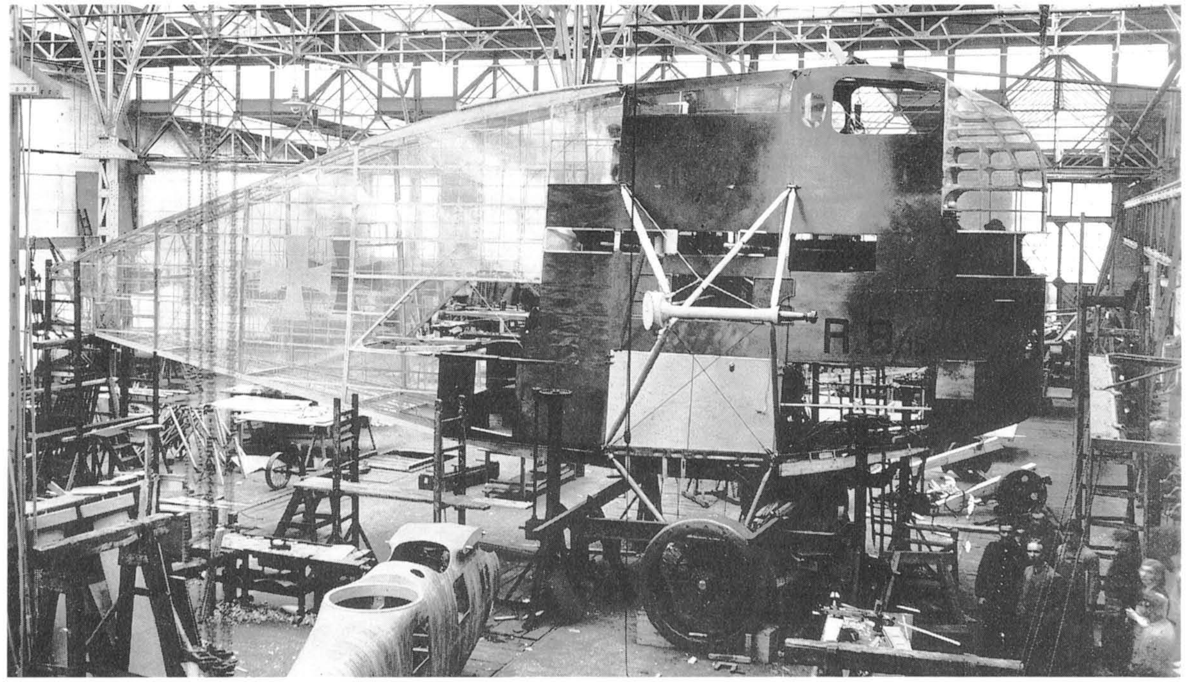


Staff Officers of Rfa 500 in September 1918. From left to right standing: Ltn. Nottebohm, Ltn. Willy Hoffmann, Ltn. d'Eau de Perthes, Ltn. Oskar Fischer, Ltn. Neuenhöfer, Ltn. Fritz Kumme, Ltn. Hampe(?), squadron doctor—name unknown. Sitting: Ltn. Karl von Biedenfeld, commanding officer, Hptm. Max Borchers, Ltn. Hugo von der Linden, Ltn. Schrader.

Oblt. Plagemann and the crew of Staaken R.VI 25/16 before a combat mission, Rfa 501 1918.

Linke-Hofmann R.I

As military aviation grew in importance, many industrial concerns were drawn into the aircraft construction programme, even though some possessed no prior experience in this field. One such was the Linke-Hofmann Works of Breslau, manufacturers of locomotives and rolling stock. The company entered the aircraft field in 1916 by repairing and constructing under licence such aircraft as the Roland C.IIa, Albatros C.III, C.X and B.IIa. In the spring of 1916 Linke-Hofmann was awarded a contract to build a four engined R-plane despite the fact it had only been in the aircraft business for a relatively short time. Assembly of the R-plane, designated R.I 8/15, began in late 1916 and was completed in early 1917 under the leadership of chief engineer Paul Stumpf, formerly chief engineer of the AEG aircraft works, and Dr. Eichberg, the works manager. Professor Mann of Breslau performed the stress calculations. All R-plane test flights were performed at the Hundsfeld airfield near Breslau.



Linke-Hofmann R.I 8/15 during assembly, showing the Cellon skin covering.

The chief characteristic of the R.I was its high, fat fuselage, an extremely awkward shape that looked aerodynamically unsound. But "form follows function". The relative inexperience of the engineering staff led it to seek assistance of the DVL laboratory at Göttingen. Here extensive wind-tunnel tests on models had shown that the "whale" fuselage which entirely filled the wing gap was endowed with a high lift–drag ratio. While this may have been true in the case of smaller machines (for example, the licence-built Roland C.IIa), it is doubtful whether the "whale" configuration was aerodynamically sound in larger aircraft for we do know that Li-Ho R.I's performance and flight characteristics left much to be desired.

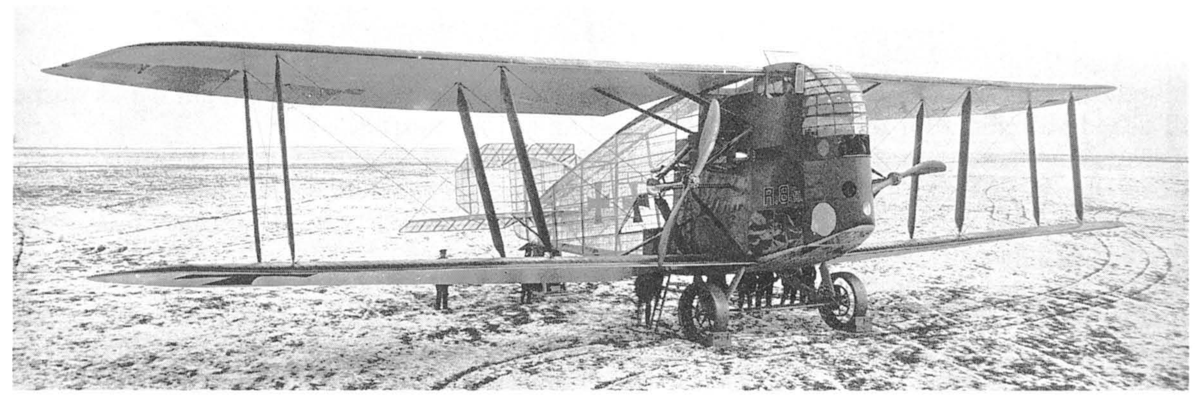
Evidently, Linke-Hofmann engineers had a free hand to try original and unusual ideas, for the R.8 had its rear fuselage completely covered with Cellon, a type of celluloid. This scheme, which had been tested on smaller aircraft, was an attempt at partial invisibility; however, it was soon found that the intense reflection from Cellon served to increase visibility rather than decrease it. Another disadvantage was that Cellon shrinks or stretches according to the weather, thereby creating constant changes of trim. It also rapidly turned yellow on exposure to sunlight. Linke-Hofmann was criticized

for using Cellon, a new and untested material about which little was known, to cover the R.8, which itself was an experimental machine.

The nose was extensively glazed from top to bottom and divided into three levels. The upper deck contained the pilots' cabin (with what must have been a splendid view) and wireless station; the middle deck contained the engines, below which were situated the bomb-aimer's cabin and four fuel tanks. Due to the height and location of the pilots' cabin, it was extremely difficult for the pilots to judge the touch down. The large amount of "greenhouse" seriously decreased visibility in poor weather, rain or during searchlight illumination due to condensation and reflection. The exposed nose afforded no protection for the crew in case of a nose-over, as happened to the second model, the R.40. The photo shows graphically the hazards of the cabin, and one wonders what became of the bombardier in the lower deck, who had four engines and fuel tanks surrounding him.

The R.I was powered by four 260 h.p. Mercedes D.IVa engines, a pair each mounted deep on either side of the fuselage parallel to the line of flight. Bevel gears connected each engine to a central drive shaft which ran across the fuselage between fore and aft engines and transmitted the power to an outrigger shaft and propeller gear-box.

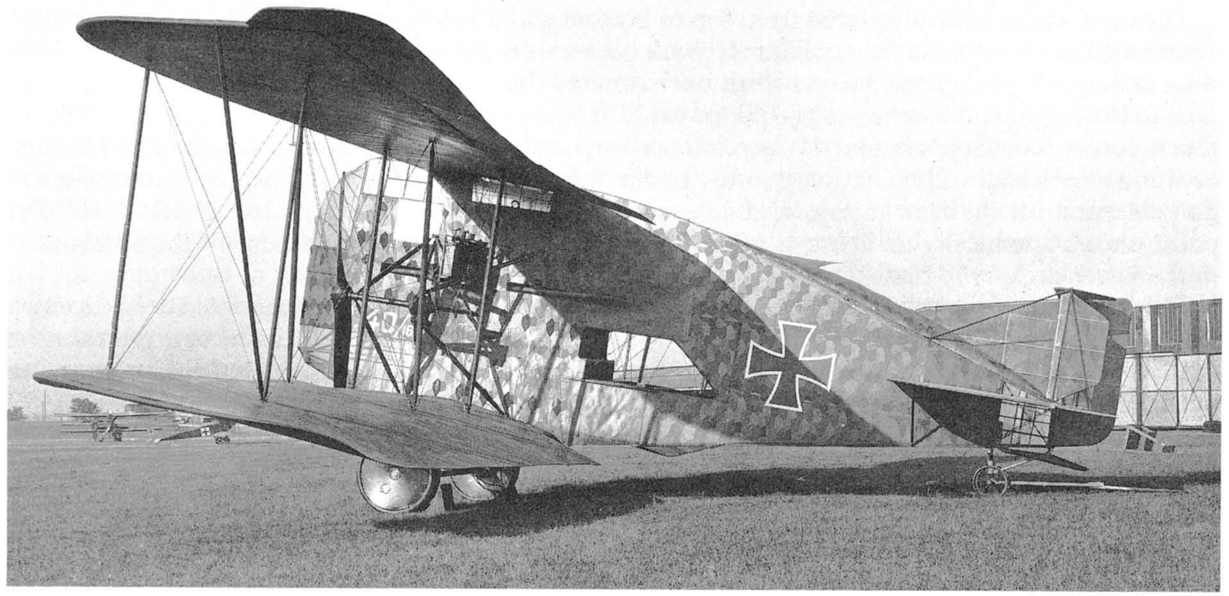
One noteworthy feature of the R.I was that the propellers were mounted on an outrigger framework completely independent of wing structure. This innovation prevented vibrations, particularly those due to propeller or transmission failure, from affecting the wing structure directly.



Linke-Hofmann R.I 8/15.

The wooden two-bay fabric-covered wings of the R.8 were extremely light, having in fact the lowest weight to total area ratio of any R-plane built. Ailerons were mounted on the upper wings only, and these were fitted with inset balancing surfaces. All four wingtips were "washed-out" at the trailing edges. The tail assembly included a curious pair of "flying" elevators mounted on top of the fin which operated in common with the conventional elevators mounted on the tailplane. The "flying" elevators were supported by the king posts of the two outboard rudders, and the whole assembly was braced by struts and cables. The undercarriage was a robust, simple V-type structure and carried a pair of massive steel-band wheels.

Testing of the R.8 began in January 1917, but flights were delayed because the unconventional steel tyres came apart during taxying trials. Improved tyres, fitted to the R.8 and subsequent Linke-Hofmann R-planes, worked quite well considering their unusual construction. In the spring of 1917 Hptm. Krupp piloted the R.8 on its maiden flight. During the course of the test programme, Krupp recalls that the flight characteristics of the R.8 began to suffer: the aircraft became mushy and almost uncontrollable, but the cause was not immediately determined. An outer diagonal strut was added at this time to stiffen the wings. On 10 May 1917 (6th test flight) Dr. Wittenstein and Lt. Hebart were at the controls when two wings collapsed at low altitude and the R.8 rammed into the ground with engines running at full power. All were saved with the exception of two mechanics

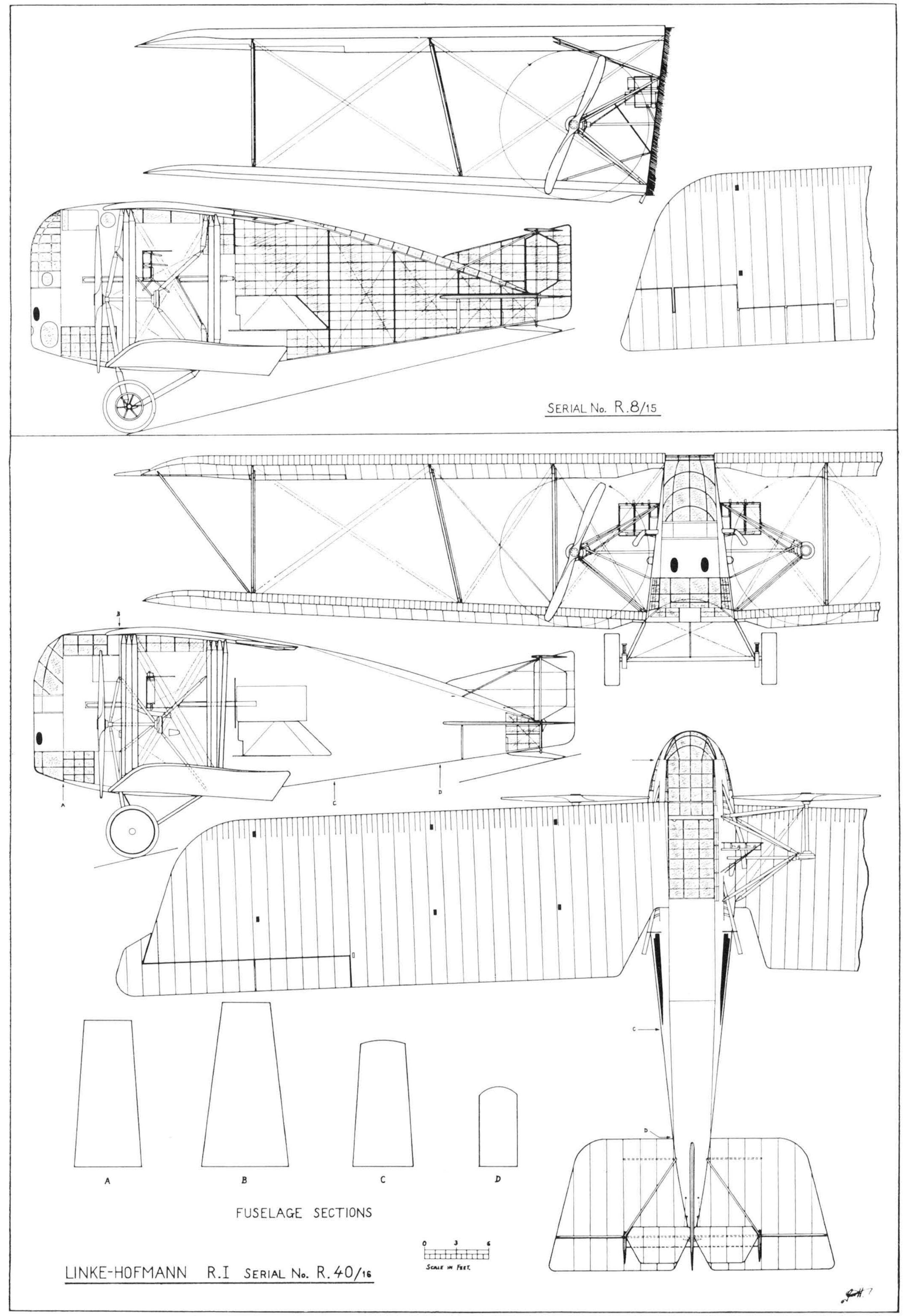


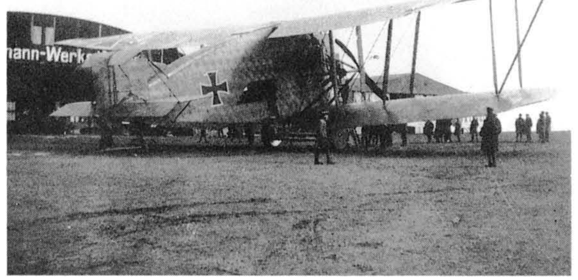
Linke-Hofmann R.I 40/16

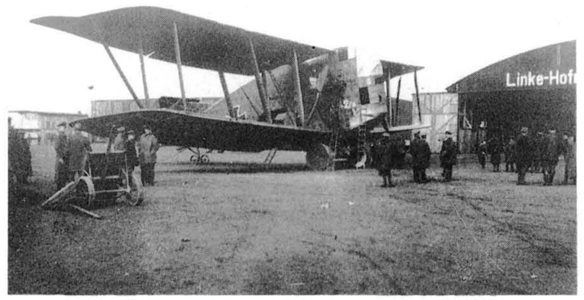
who ran into the flames. In retrospect, it was determined that the exceedingly light wings warped and flexed in flight, with the resulting mushy feeling at the controls.

Because the R.8 was not fully tested at the time of its destruction, a series of improved models (R.I 40/16 to 42/16) were ordered by Idflieg. By the end of 1917 the R.40 was completed with certain modifications that incorporated the lessons learned from its predecessor. The wings, now greatly strengthened internally, were supported by three bays instead of two and fitted with overhanging balanced ailerons. The propeller gear-boxes were held by a new outrigger framework, more efficient radiators were mounted and the amount of Cellon was drastically reduced. The R.40 was equipped with the latest-type of landing gear designed by Linke-Hofmann engineers, who, incidentally, were

Linke-Hofmann R.I 40/16 fitted with faired interplane struts.







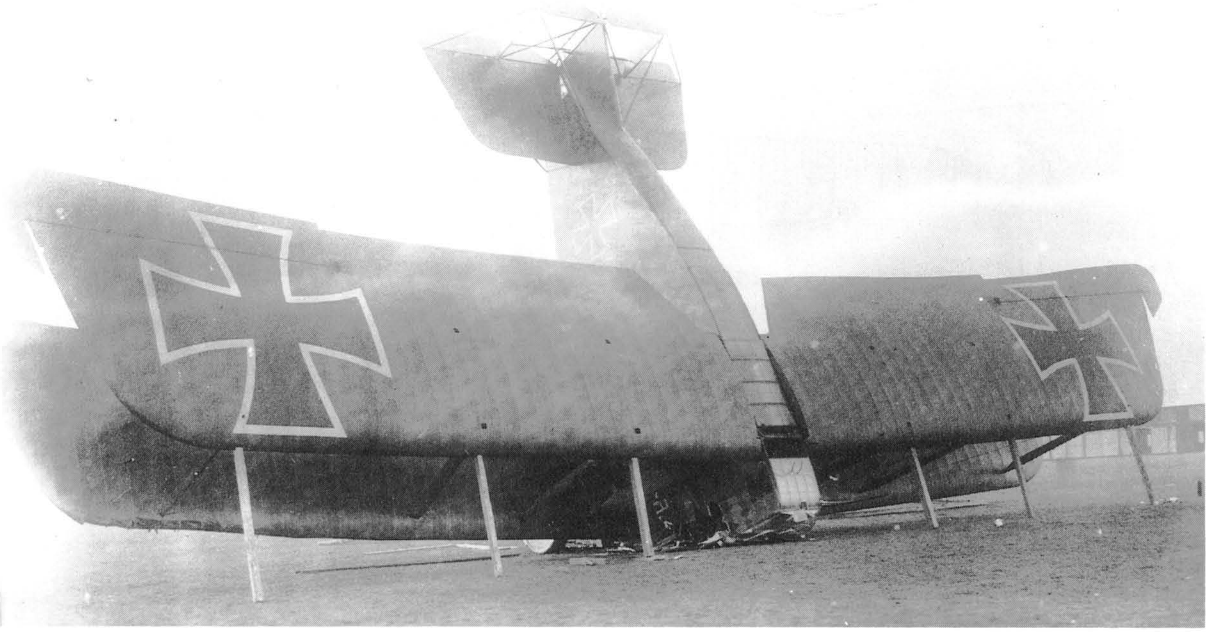
Linke-Hofmann R.I 42/15

particularly energetic and thorough in seeking solutions to the landing-gear problem. The shock absorbers consisted of many small steel coil springs arranged to take the place of rubber shock cords.

Dorsal, ventral and beam gun positions were provided, and the beam positions allowed light to enter the engine compartment and permitted vapours to escape.

The performance attained by the R.40 was not satisfactory, but it was said that the aircraft had good manoeuvring qualities. The slow landing glide required a great deal of skill on the pilots' part, more so because of the high position of the cabin. During testing it is presumed that the pilot misjudged his height above ground. The R.40 landed hard and broke an axle, causing the aircraft to crash on its nose. It was probably not rebuilt after this accident. One pilot who today looks back on flying the R.I called it "not an aircraft but a sickness".

Modifications and Göttingen pedigree notwithstanding, the R.I design was unsuccessful, and



The end of the Linke-Hofmann R.I 40/16.

acceptance was declined by Idflieg. A contemporary report states that the R.41 and R.42 were almost ready for acceptance in January 1918. Further information regarding the R.41 is lacking. The completed R.42 was photographed on the Linke-Hofmann aerodrome but details are not known.

Colour Scheme and Markings

R.8/15. The rear fuselage and tail were covered with transparent Cellon, allowing ribs and stringers to show through. The remainder of the fuselage and upper wing surfaces were painted in a dark colour, possibly olive-green or grey; the lower surfaces were painted a light colour. Plain black Patée crosses were painted over the Cellon on the fuselage. Those on the wings were edged in white. No markings were carried on the tail. The serial number was painted in black with white outlines on both sides of the nose.

R.40/16. The machine was covered with printed camouflage fabric. The wing fabric was taped with light-coloured tape where it was sewn to the ribs; possibly it was light blue following the practice used on fighter aircraft. Patée crosses were painted on the wings and fuselage, but not on the tail. The serial number appeared in white on both sides of the nose.

SPECIFICATIONS

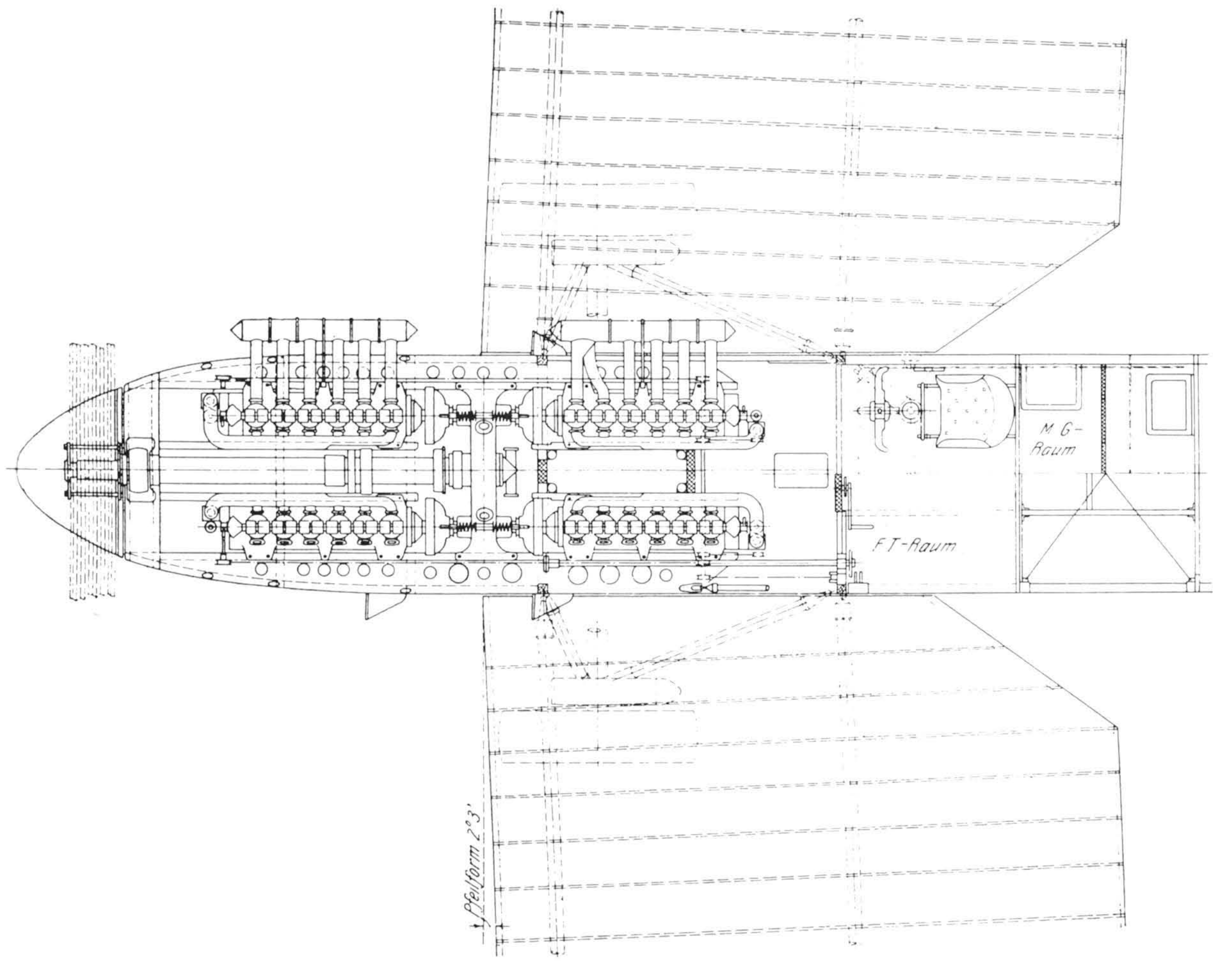
Type:	Linke-Hofmann R.I 8/15
Manufacturer:	Linke-Hofmann Werke A.G., Breslau
Engines:	Four 260 h.p. Mercedes D.IVa engines
Propeller Revolutions:	750 r.p.m.
Dimensions:	Span, 32·02 m. (105 ft. 0½ in.)
	Length, 15·56 m. (51 ft. 0½ in.)
	Height, 6·78 m. (22 ft. 3 in.)
Areas:	Wings, 264 sq. m. (2841 sq. ft.)
Weights:	Empty, 5800 kg. (12,789 lb.)
	Loaded, 9000 kg. (19,845 lb.)
Performance:	Maximum speed, 140 km.h. (87 m.p.h.)
Armament:	Provision for dorsal, ventral and beam machine-gun positions
Service Use:	None

SPECIFICATIONS

Type:	Linke-Hofmann R.I 40/16
Manufacturer:	Linke-Hofmann Werke A.G., Breslau
Engines:	Four 260 h.p. Mercedes D.IVa engines
Propeller Revolutions:	750 r.p.m.
Dimensions:	Span, 33·2 m. (108 ft. 11 in.)
	Chord upper, 5 m. (16 ft. 5 in.)
	Chord lower, 4·7 m. (15 ft. 5 in.)
	Length, 15·6 m. (51 ft. 2 in.)
	Height, 6·7 m. (22 ft.)
	Propeller diameter, 4·3 m. (14 ft. 1 in.)
Areas:	Wings, 265 sq. m. (2851 sq. ft.)
Weights:	Empty, 8000 kg. (17,640 lb.)
	Useful load, 3200 kg. (7056 lb.)
	Loaded, 11,200 kg. (24,696 lb.)
Wing Loading:	42·3 kg./sq. m. (8·7 lb./sq. ft.)
Performance:	Maximum speed, 130 km.h. (80·8 m.p.h.)
	Climb with full load, 3000 m. (9843 ft.) in 120 mins.
Armament:	Provision for dorsal, ventral and beam machine-gun positions
Service Use:	None

Linke-Hofmann R.II

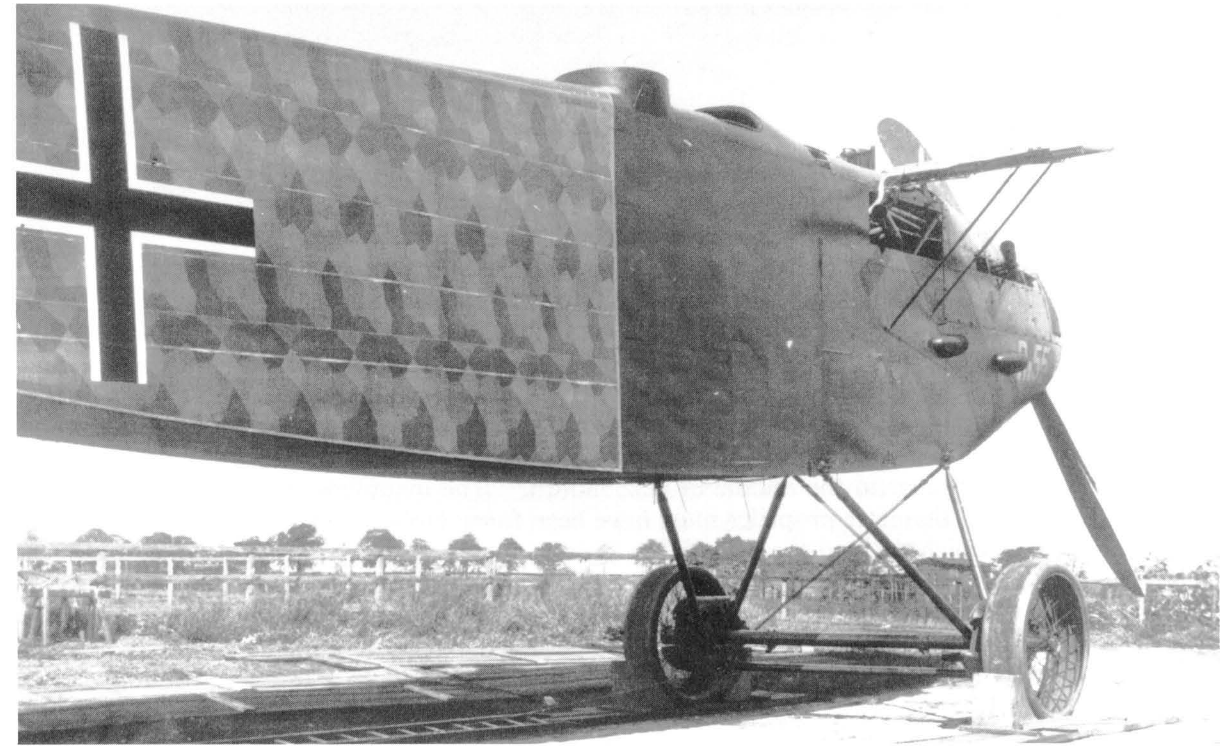
The poor showing of the R.I led Linke-Hofmann along a radically different line of approach. The outcome of their efforts was an aircraft that must surely rank among the unique in aviation history. If wind-tunnel tests were not conclusive in providing an answer to the question of size, why not build a giant version of the efficient and well-proven single-engined biplane? In the hope that flight and performance characteristics could be reproduced, an almost exact copy was built, with the exception that it was three times larger than normal. It is quite impossible to grasp the immense size of the R.II 55/17 just from photographs. (For some reason, no photographs exist with men standing near the aircraft to give a feeling of scale.) The single airscrew, the pilots' cockpit, the gun mounts and the conventional landing gear all trick the unsuspecting eye. Proper scale can best be demonstrated by mentally placing a 6 foot man next to the 5 foot diameter wheels or the 23 foot diameter Garuda propeller. It is believed that the R.II was the largest single-propeller aircraft ever built.



Linke-Hofmann R.II Engine and power transmission arrangement.

The four coupled 260 h.p. Mercedes D.IVa engines which drove this huge propeller were located in the nose of the R.II. They were arranged in a port and starboard pair with crankshafts facing each other. Each engine had its own friction and ratchet-lock clutch coupled to a heavily-dimensioned drive gear which lay between them. These two gears were in turn coupled to a robust 2½ foot diameter central spur gear which drove a 9 inch diameter torque tube (at 545 r.p.m.) that ran between the

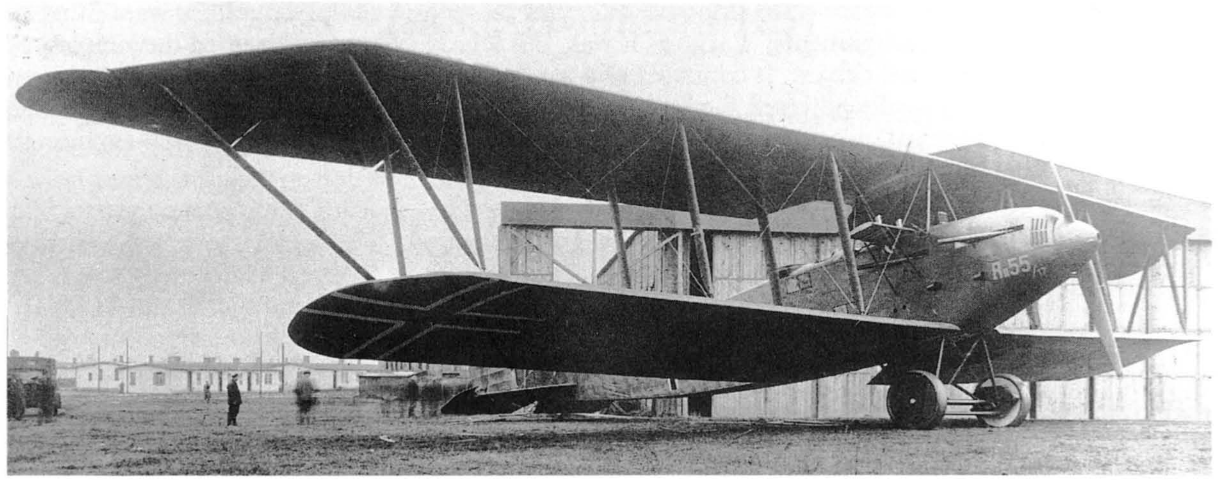
forward engines to the propeller hub. Massive universal joints and sliding couplings were fitted to absorb vibrations and misalignments. Large as it was, this sturdy system represented the simplest of all the coupled four-engined drives. It consisted of a total of three gears as compared with the seven to ten gears on other centrally powered R-planes. As was the case with most coupled drives, this one was exhaustively investigated on an indoor test stand. It was claimed that this well-engineered assembly was very reliable in flight.



The camouflage pattern and taped stringers are clearly seen in this view of the dismantled Linke-Hofmann R.II. Note the propeller broken during ground tests.

The radiators were mounted as small stub wings within the wing-gap, and an oil cooler was affixed above the engine-room decking. The rectangular fuselage was constructed of wood and was cable-braced throughout. The pilots' cockpit was situated below the upper wing trailing edge, which was cut away to improve the view. Located immediately aft were two dorsal machine-gun positions placed side by side in the width of the fuselage. The nose was plywood-covered back to the gun positions, and the remainder was covered with fabric. The wings were of all-wood construction and of equal chord, and ailerons were fitted to the upper wing only. The large biplane tail comprised three fins and rudders, and both upper and lower tailplanes were fitted with elevators.

The undercarriage was simple and robust and represented the culmination of Linke-Hofmann's engineering efforts to produce a reliable landing gear for giant aircraft. Two massive steel-tyre wheels were supported by a multi-coil spring shock absorber. The efficiency of this configuration proved itself in January 1919. Due to a blanket of snow over the countryside the pilot misjudged the extent of the airfield and landed short of the field in marshy ground. The wheels broke through the thin layer of frozen crust and the aircraft rolled over two ditches before coming to a halt within a distance of 79 feet. The wheels had sunk 12 inches into the ground without the machine overturning. it was impossible to move the R.II under its own power, and a steam tractor was required to pull it out. The large, heavy wheels did present some difficulties, however, and Linke-Hofmann engineers did consider using a "vaned" wheel which the airstream would spin, thereby reducing landing shocks.



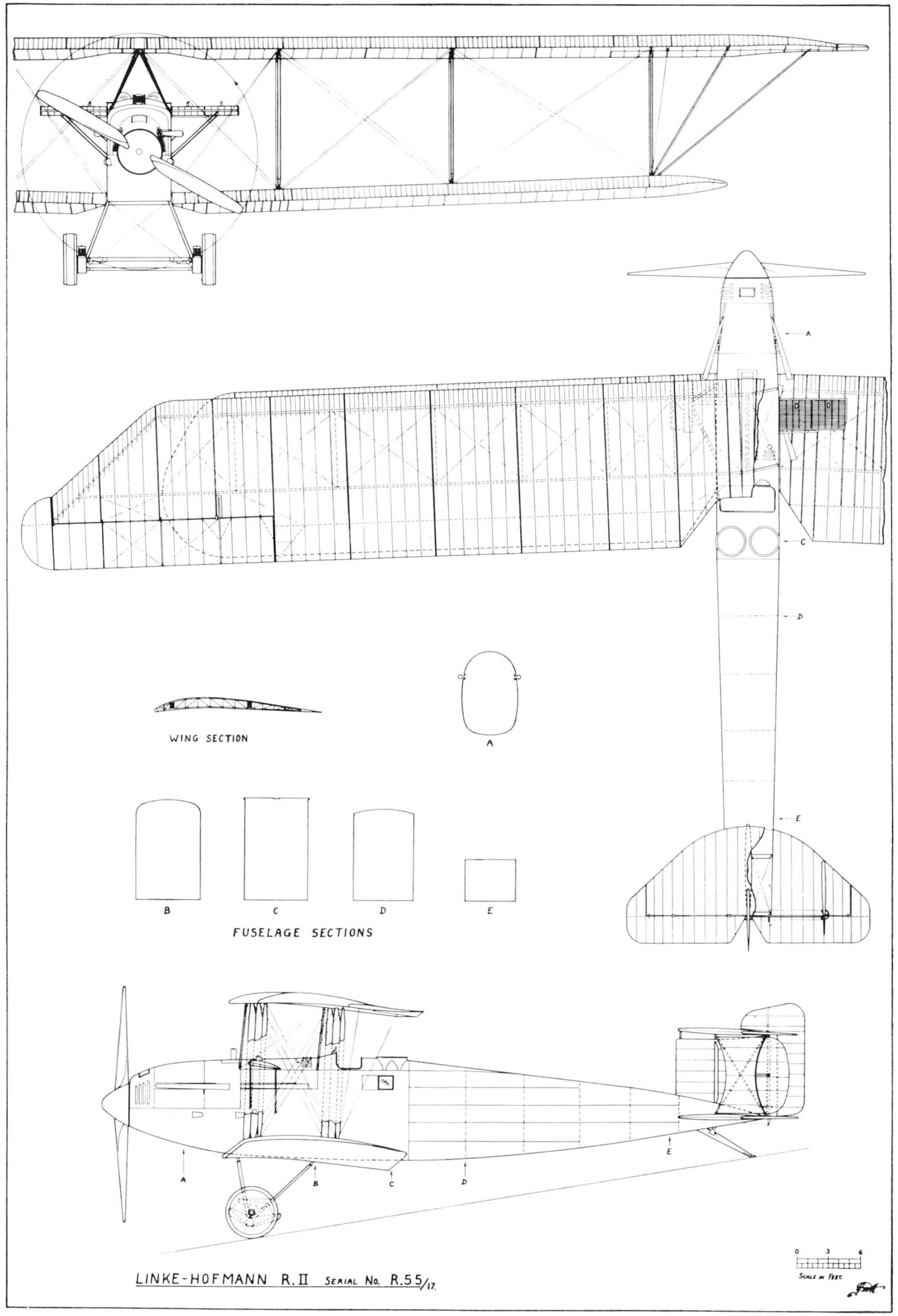
Linke-Hofmann R.II 55/17.

Although the R.55 and R.56 were slated for delivery in July 1918, the R.55 did not make its first flight until January 1919. The major cause of the delay was the development of a suitably matched propeller. In a report dated September 1918, we read that: "The transmission of the R.55 ran perfectly during ground tests, but the propeller proved to be too small. It is expected the aircraft will fly with a new propeller in the middle of next month." The manufacturing problems involved in constructing a 23 ft. diameter propeller must have been formidable. Very likely it was the lack of a suitable propeller which delayed the first flight of the R.55 until 1919.

The R.56 was almost completed but never flew. As in other later R-plane projects, it had been planned to add a Brown-Boveri supercharger geared to the rear of the central spur gear.

For a time, Waldemar Roeder was second pilot during the R.55 test flights. Here is how he recalls a queer aspect of the R.55 in flight.

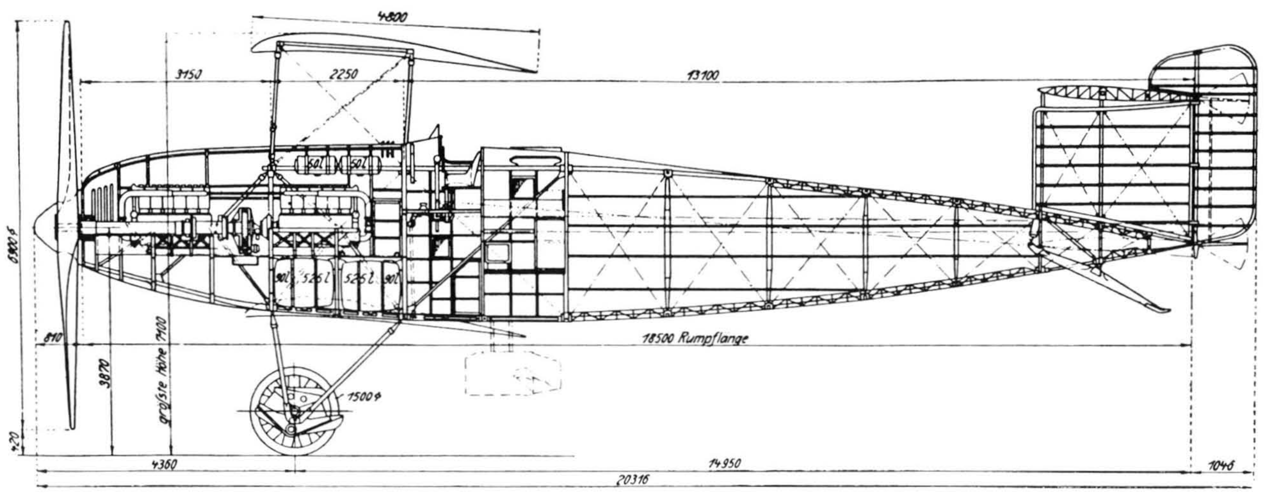
Linke-Hofmann R.II 55/17.



It was my good fortune to fly with test pilot Wicoreck. Since the designer had chosen to keep the propeller tip velocity equal to that of smaller diameter, higher rpm propellers, that of the R.55 turned at only 545 rpm. It was an extraordinary sensation to be pulled through the air by a propeller that was turning so slowly.

Judging from contemporary accounts, the R.II was easy to fly, having approximately the characteristics of a single-engined type. All controls were placed in ball bearings and were aerodynamically balanced, enabling the plane to be flown literally single-handed during gusty weather in January 1919.

The R.II could carry a *maximum* useful load of 7000 kg. for an all-up weight of 15,000 kg. Flying on two engines with reduced payload (2400 kg.), it was calculated that 9½ hour flights could be made.



Linke-Hofmann R.II. Note semi-retractable turret shown in broken line under the fuselage.

The bomb load was carried on external wing racks, though internal stowage was planned. The crew consisted of two pilots, one navigator, one radio operator and two gunner/mechanics. No details are known concerning the end of R.55, other than a report that it crashed before completing its test programme. Perhaps pieces of the R.55 or R.56 were shipped to England. According to a November 1920 issue of *Flugsport*, the Inter-Allied Control Commission confiscated the fuselage of a Linke-Hofmann R-plane and sent it to the Isle of Grain for study.

The authors were puzzled by the box-like shape hanging from struts beneath the fuselage as shown in contemporary plans. Was this an early version of the retractable "dust-bin" turret or auxiliary fuel tank? A patent search proved it to be the former, a semi-retractable turret which would allow the gunner to enter while the machine was in the air. There is no indication that the turret was fitted to the prototype, but rather that it was a refinement planned for later series.

For commercial purposes a cabin for twelve passengers was planned situated immediately aft the pilots' cockpit. However, Armistice restrictions prevented further development of the R.II, ending the story of a most unusual aircraft.

Colour Scheme and Markings

The overall finish was printed camouflage fabric, with the wing-ribs and fuselage stringers taped in a similar manner to R.40/16. Engine cowling panels were painted all one colour, probably grey or perhaps olive-green. Full chord Latin crosses were painted on the wingtips and fuselage sides, but none on the tail. The serial number printed white appeared on both sides of the forward cowling.

SPECIFICATIONS

Type:	Linke-Hofmann R.II
Manufacturer:	Linke-Hofmann Werke A.G., Breslau
Engines:	Four 260 h.p. Mercedes D.IVa engines
Dimensions:	Span upper, 42·16 m. (138 ft. 4 in.)
	lower, 33·96 m. (111 ft. 5 in.)
	Chord, 4·8 m. (15 ft. 9 in.)
	Gap, 4·5 m. (14 ft. 9 in.)
	Length, 20·32 m. (66 ft. 8 in.)
	Height, 7·1 m. (23 ft. 3½ in.)
	Tailspan, 7 m. (22 ft. 11½ in.)
	Chord, 2·59 m. (8 ft. 6 in.)
	Gap, 2·4 m. (7 ft. 10½ in.)
	Wheel track, 4 m. (13 ft. 1½ in.)
	Wheel diameter, 1·5 m. (4 ft. 11 in.)
	Propeller diameter, 6·9 m. (22 ft. 7½ in.)
Areas:	Wings, 320 sq. m. (3443 sq. ft.)
Weights:	Empty, 8000 kg. (17,640 lb.)
	Useful load, 4000 kg. (8820 lb.)
	Loaded, 12,000 kg. (26,460 lb.)
Wing Loading:	37·8 kg./sq. m. (7·8 lb./sq. ft.)
Performance:	Maximum speed, 130 km.h. (80·8 m.p.h.)
	Duration, 7 hrs.
	Climb, 1000 m. (3281 ft.) in 8 mins.
	2000 m. (6562 ft.) in 20 mins.
	3000 m. (9843 ft.) in 45 mins.
	Ceiling, 3200 m. (10,499 ft.) in 120 mins.
Armament:	Provision for two dorsal and one ventral machine-gun positions
Service Use:	None
Cost:	450,000 marks

Mercur R-plane Project

The little-known Mercur-Flugzeugbau G.m.b.H. was organized during the war on 15 April 1915 in Berlin. Its main activity consisted of building Albatros training machines under licence and the repair of various two-seater aircraft. Concurrent with this work, Mercur constructed some obscure single-seat and light two-seat fighters of its own design. In the summer of 1918 an R-plane was in the project stage and preparation of the detail drawings was imminent. The R-plane was to have been powered by four 260 h.p. Mercedes D.IVa engines and carry a crew of eight, a bomb load of 2000 kg. and a defensive armament of six machine-guns. Unfortunately, as with all of Mercur's designs, further details are lacking.

Neuber R-plane Project

With the apparent success of ground and flight tests on the VGO.II of the downward firing cannon designed by Lt. Dr. Ernst Neuber for attacking ground targets from an R-plane, an order was placed for a 10·5 cm. calibre cannon on 7 November 1917. To transport this cannon over enemy targets, Neuber proposed a cannon-carrying R-plane based on his patent No. 305,039. The patent described a conventional biplane airframe with the inner structure (consisting of the centre fuselage, engine mounts and cannon support) specially reinforced to absorb the recoil forces of the cannon

which was mounted amidships. It was calculated that the inner structure's 7000 kg. weight and strength would be sufficient to absorb the 3000 kg. recoil. The aircraft was to be powered by eight 245 h.p. Maybach Mb.IVa engines mounted in streamlined, fully-enclosed nacelles. Two engines each were geared to drive the tractor and pusher propellers. The larger tractor propellers were to run at 900–1000 r.p.m. and the pusher propellers in an opposite direction at 1300 to 1400 r.p.m.

The armament was to consist of one 10·5 calibre cannon for attacking ground targets and battleships. A total of 110–120 rounds of ammunition was provided for the cannon, which had a rate of fire of 20 rounds per minute (called a three-quarter automatic cannon by the Germans). One man would aim and fire while a second loaded the cannon. Eight machine-guns comprised the defensive armament. Each of the four gun turrets was to have two guns and, if necessary, several machine-guns could be mounted in sliding side doors. The large gun turrets were located in the extreme nose, in the upper and lower rear fuselage and on a small projecting platform located underneath the pilot's cockpit. Should it be required, machine cannons could be included as defensive armament. Armour plating was provided for the pilots' seats and the fuel tanks. A teardrop shaped command post was proposed for the upper wing centre section from which the aircraft commander could follow the aircraft's movements and give commands by means of a machine telegraph. In all other aspects the Neuber project was rather conventional, outside of being somewhat larger than existing R-planes.

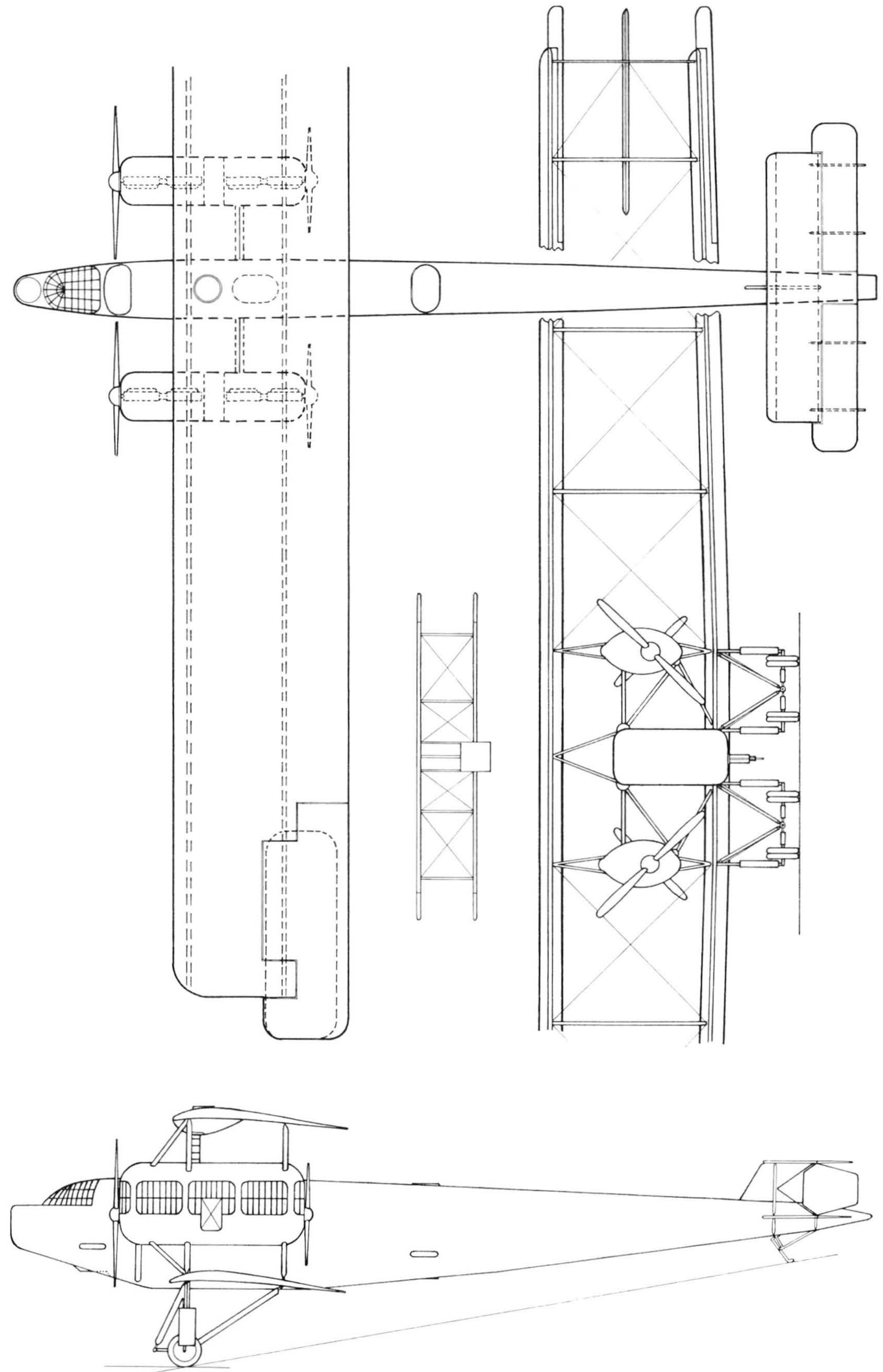
SPECIFICATIONS

Type:	Neuber Cannon-carrying R-plane Project
Manufacturer:	Designed by Lt. Dr. Ernst Neuber
Engines:	Eight 245 h.p. Maybach Mb.IVa engines
Dimensions:	Span, 54·5 m. (178 ft. 9½ in.)
	Length, 33·5 m. (109 ft. 10½ in.)
	Height, 6·5 m. (21 ft. 3½ in.)
	Chord, 6·0 m. (19 ft. 8½ in.)
	Gap, 6·0 m. (19 ft. 8½ in.)
Wing Loading:	30 kg./sq. m. (6·14 lb./sq. ft.)
Performance:	Range, 900 km. (559 miles)
Armament:	One 10·5 cm. cannon with 110–120 rounds of ammunition; eight machine-guns

Poll Giant Triplane

During 1919 an Inter-Allied Aeronautical Control Commission team reported on the partially-finished remains of a fantastic ten-engined triplane found in a hangar at the Poll airfield near Cologne. For many years the only information regarding this mystery aircraft was that described in the I.A.A.C.C. report dated 29 September 1919. From an engineering point of view the report was fairly comprehensive and was entirely in keeping with the I.A.A.C.C. objectives—not only to control but to describe new German aviation developments. Unfortunately, virtually nothing was mentioned regarding the history of this machine, so that for many years speculation has surrounded its existence. The only clue to the identity of the aircraft was that the designer's name was Forstmann. But the following important statements appeared in the report: "It appears that the 'Forstmann' Giant was intended to carry petrol for 80 hours flight, to have a speed of about 130 km.h. and to land at about 90 or 100 km.h." Then later on: "Function—heavy bombing, long distance machine, alleged to have been intended to bomb New York. No trace of any gear or bomb release gear found." These statements were to be significant in the search for the Poll Giant's true identity, because they established a connection with a document in the German Naval Archives.

While searching through the voluminous Naval archives a memorandum dated 18 October 1917 came to the author's attention, quite by chance. It had no heading and ostensibly was a short information note prepared for some high-ranking officer. It read:

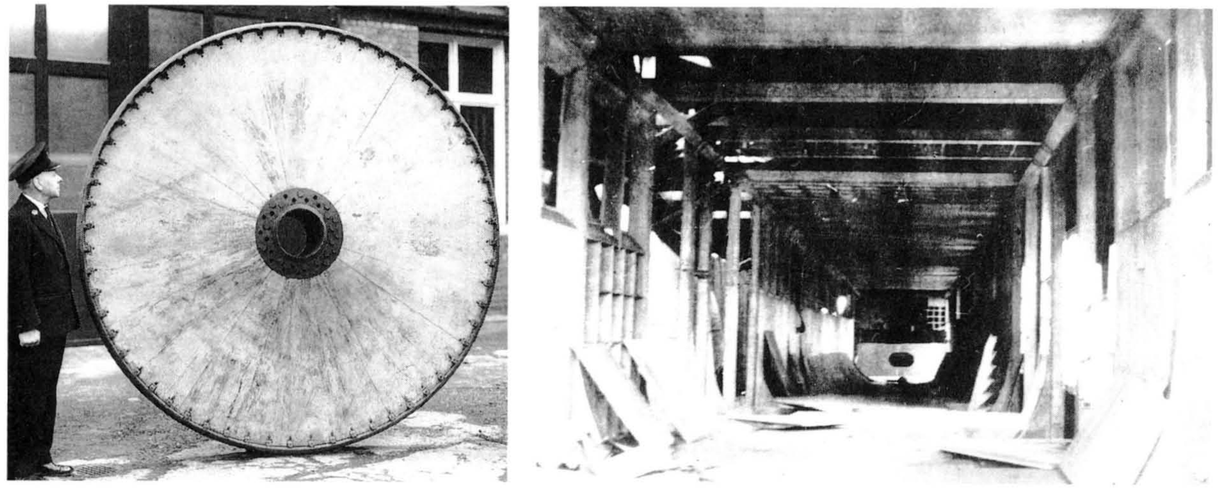


NEUBER CANNON R-PLANE PROJECT

A transport aircraft with ten engines capable of flying to America was financially supported by Brüning and the Deutsche Bank. The Navy became interested in the project because of its potential military application. The construction work has lagged behind and costs have risen so that further financing has been refused. The Company approached the Navy for funds, but the Navy declined because its interest was only of technical nature. Mannesmann was ready to re-finance the project, but the Navy considers it worthwhile to inhibit further construction due to the scarcity of material and labour.

The signature was unintelligible.

It is now known that the Poll triplane and the Brüning-Deutsche Bank project were identical. From the outset, the Poll Giant was intended as a long-range *transport* not bomber. Its designer was Villehad Forssman, creator of the early SSW-Forssman R-plane. Forssman enjoyed a close working relationship with Brüning & Sohn A.G. owner of "the four largest factories in Germany for the manufacture of quality plywood" and operated Fahrzeugbau Brüning at Grossauheim (near Hanau) for manufacturing transport vehicles, including aircraft. In fact Fahrzeugbau Brüning's registered trademark was an exact front view of the Poll triplane. To utilize Brüning's woodworking skills and sell plywood, Forssman actively promoted the company through his design and patent office in Berlin. In this connection, in April 1916 Forssman contacted Anthony Fokker and offered to have Brüning build several plywood wings, at no cost, according to Fokker specifications. Fokker quickly submitted the required wing drawings. Also involved with



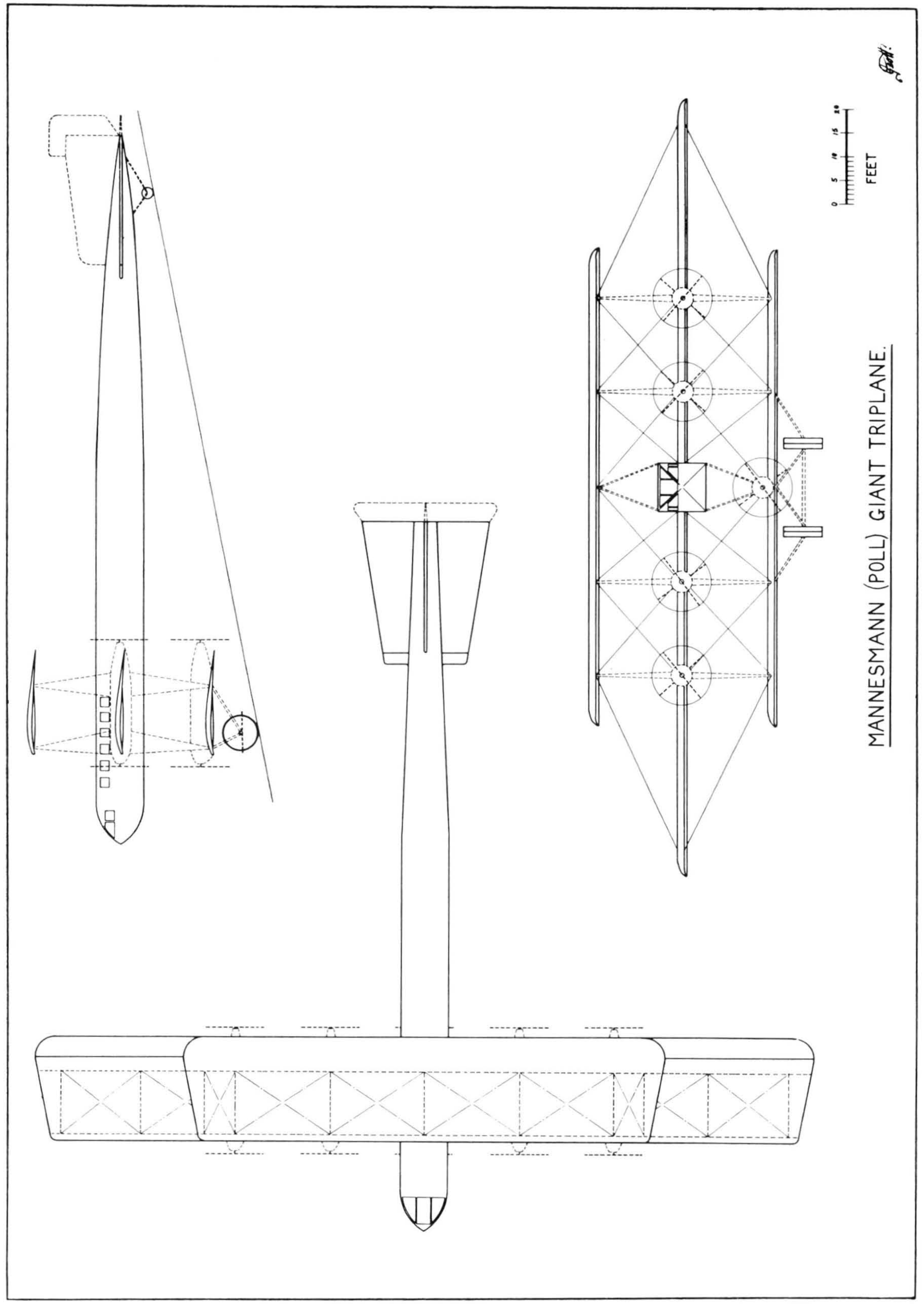
One of the huge wooden wheels of the Poll Giant and an interior view of the 9ft. 3in. square fuselage.

Fahrzeugbau Brüning was engineer Thorsten von Carlheim, a fellow Swede, who worked for Forssman in Berlin and Grossauheim.

Hptm. Krupp, now an Rea staff officer, recalled inspecting the Poll Giant at the request of Admiral Lahs and felt certain that Villehad Forssman was the designer. According to the *Illustrated London News* (p. 992, 1920), the Poll Giant was "intended to fly to America and drop propaganda leaflets over the United States before that country enter the war." Such a far-fetched proposal was entirely in keeping with Forssman's creative fantasy. The "Mannesmann" of the German Navy report was the Mannesmann Wafffen & Munitions Werke in Westhoven near Cologne who, in 1918, were constructing a small radio-guided flying missile designed by Forssman. Although no proof exists, Mannesmann was surely involved in the construction of the Poll Giant.

Waldemar Roeder recalls visiting the Poll Giant construction site as follows:

A very interesting project, under construction in 1918, was the one by Forssman. During my service with the Rea in Cologne, I learned of a huge triplane being built near Kahl (between Hanau and my home, Aschaffenburg; there was no airfield in the vicinity). Naturally, I went there as soon as I could and found a rather primitive building almost in



the middle of the woods. Unfortunately, I do not remember who took me through the workshop, but I was impressed by the clean workmanship. Wings and nacelles were made of plywood, the former not yet covered with fabric. The very handsome engine nacelles were intended for a tractor and pusher engine each.

Since not all of the Poll Giant's components were found (engines, engine bearers, control surfaces, undercarriage and sections of the tail were missing), it is likely that this aircraft was constructed in at least two locations. The engine nacelles and other parts had not yet been shipped to the Poll airfield site when it was inspected by the Allies.

The triplane wing was characterized by a middle wing with a much greater span than the outer two wings. The ribs were set fairly wide apart, and the box-section compression ribs were spaced at approximately 20 foot intervals. These thickened between the spars so that some 5 inches projected below the curve of the camber. The entire wing surfaces were covered with three-ply wood reinforced by a layer of fabric applied to the top veneer. The I.A.A.C.C. considered the workmanship good, but thought the structure to be weighty and disproportionately weak. Ailerons were to have been fitted to the middle wing only. Eight tandem engines were located at the strut intersections on the middle wing. The remaining two tandem engines were located below the fuselage at the centre of the lower wing. No information is available as to the type and horse-power of the contemplated engines.

The rectangular centrally-mounted fuselage was built of wooden longerons and cross-members reinforced with diagonal cable bracing. Although the fuselage was covered with three-ply wood, the I.A.A.C.C. team stated that the fuselage appeared weak and felt the three-ply covering added unnecessary weight. Because cable bracing across the fuselage interior was omitted, the inner (9 feet 3 inches square) fuselage was free from obstruction. The inner sides of the fuselage were covered by a second plywood layer. If strength were uppermost in the designer's mind he had no regard for weight, and the impression was that the Poll Giant was quite heavy in structure. When one considers that the fuselage was 150 feet long, some 12 feet longer than the wingspan of the Staaken R.VI, the designer's preoccupation with strength and rigidity is perhaps excusable.

Only a portion of the tailplane was available for inspection by the I.A.A.C.C. team. The elevators, fin and rudder were missing. A point of much interest to the Commission was that the leading edge of the tailplane was hinged and connected in a manner to assist in working the elevators. A recommendation was made by the I.A.A.C.C. team to test this arrangement in a British wind tunnel.

All that was found of the undercarriage was one of the huge, 7 foot 9 inch diameter wheels, which were entirely built of wood with the exception of the steel hub. For many years this wheel was on exhibition at the Imperial War Museum in London, where it is now in storage along with a section of the fuselage.

While there is no question that the Poll Giant was immense in concept, the naïveté of its construction betrays the designer's inexperience in methods of aircraft design and fabrication. It is hoped that future research will bring to light the full history of this fascinating but forgotten aircraft. The accompanying provisional general arrangement drawing is based on all available data.

SPECIFICATIONS

Type:	"Poll" Giant Triplane
Manufacturer:	Unknown (initially financed by Brüning and the Deutsche Bank)
Engines:	Ten tandem engines
Dimensions:	Span: middle, 50·3 m. (165 ft.)
	top and bottom, 31·1 m. (102 ft.)
	Chord, 6·7 m. (22 ft.)
	Gap (upper and lower), 5·5 m. (18 ft.)
	Fuselage length, 45·7 m. (150 ft.)
	Maximum fuselage depth, 2·8 m. (9 ft. 3 in.)
	Wheel diameter, 2·4 m. (7 ft. 9 in.)
Performance (Est.):	Maximum speed, 130 km.h. (80·8 m.p.h.)
	Landing speed, 90–100 km.h. (56–62·5 m.p.h.)
	Duration, 80 hrs.

Roland R.I

The Luft-Fahrzeug-Gesellschaft m.b.H. in Berlin was founded in 1908, and during the war it was best known for a succession of handsome single-seat fighters and particularly the finely streamlined Roland C.II "Walfisch" two-seater of 1916. It is not generally known that parts of a four-engined 1000 h.p. R-plane were destroyed along with other advanced types when the Adlershof factory was levelled by fire on 6 September 1916. The designation Roland R.I is provisional, and no additional information concerning its configuration or estimated performance has been uncovered. Within four weeks of the Adlershof disaster the first aircraft was delivered from Roland's newly acquired works in Charlottenburg. But after this the firm concentrated on building single-engined fighter and observation types, and not until 1918 did it again consider constructing multi-engined types, of which details are lacking.

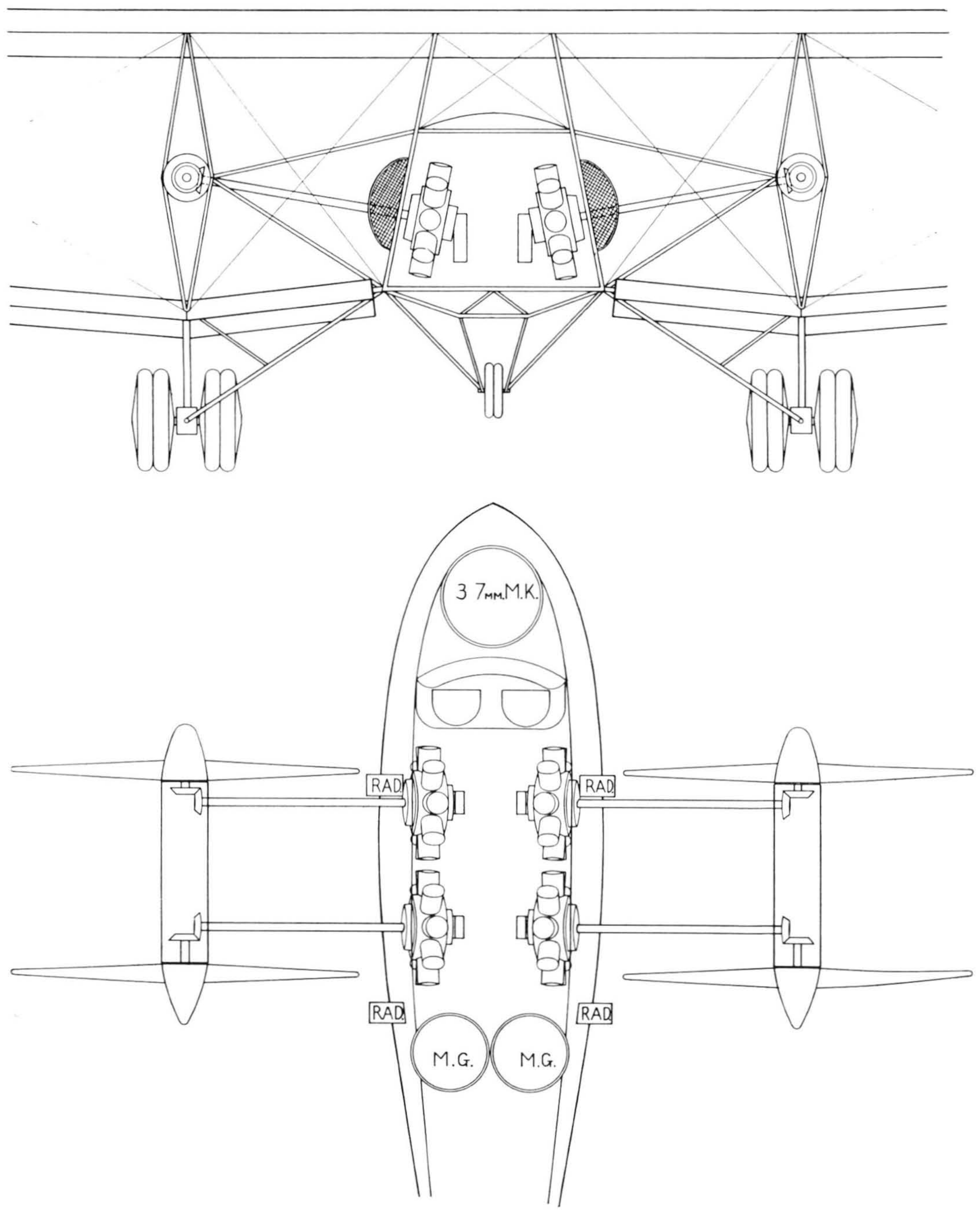
Schütte-Lanz R.I

In 1909 Dr. Johann Schütte and Dr. Karl Lanz founded the Luftschiffbau Schütte-Lanz at Mannheim to build airships for commercial and military purposes. Their successful venture subsequently led to the delivery of twenty airships to the German Army and Navy during the war, establishing Schütte-Lanz as the second largest supplier of airships to the German Armed Forces.

Following in the footsteps of so many German concerns, Schütte-Lanz began to experiment with a variety of aircraft types during the early years of the war. In late 1915 Dipl.-Ing. Wilhelm Hillmann, chief engineer of the Schütte-Lanz aircraft department, designed an all-steel R-plane at the request of Dr. Schütte. It was to be powered by four 300 h.p. water-cooled radial engines based on the Salmson–Canton–Unné engine, an example of which had been procured and improved upon by the Robur Motoren Gesellschaft, a Schütte-Lanz subsidiary. At the time the proposal was tendered the Robur engine was undergoing bench tests at the Flugzeugmeisterei in Adlershof. The 9000 kg. R-plane project, to be equipped with a 3·7 cm. machine cannon and jettisonable fuel tanks, did not receive a favourable reception from the military authorities, who considered the project too advanced. Schütte-Lanz lacked the financial resources of larger companies, such as Siemens-Schuckert and Staaken, and was forced to drop the project.

In October 1915 Schütte-Lanz established a branch works at Zeesen for two reasons: the need of more space, and the request of Idflieg that another airship works be erected in case of air raids on Mannheim. The new facilities were finished in April 1916, and large-scale aircraft production began when Schütte-Lanz (Schül) received a contract in October 1916 to build 250 Ago C.IV machines under licence. Shortly thereafter (winter 1916–17) as the VGO-Staaken types began to achieve front-line capability, Schütte-Lanz was given a contract for the construction of six Staaken R.VI aircraft under licence. At the time the contract was placed the myriad constructional details had not been entirely settled. As might be expected, continual changes and improvements by Staaken kept the final drawings in a state of flux, thereby delaying the construction of the licence machines. This delay was responsible for Idflieg's reduction of the original contract to three Staaken R.VI machines. The R.27, R.28 and R.29 were built by Schütte-Lanz, the first of which was delivered in the latter part of 1917. All three R-planes were operational and were subsequently destroyed in crashes (see Staaken R.VI and Operational History chapters).

Three Staaken R.XIVa machines numbered R.84 to R.86 were under construction by Schütte-Lanz at the end of the war, and their status as of 15 January 1919 was as follows: The R.84 and R.85 were three-quarters completed and the R.86 parts were finished and final assembly had begun. The German Government gave permission to finish these machines as civil transport aircraft. Only the R.84 was completed, but it was soon scrapped along with the R.85 and R.86 in accordance with the Armistice treaty and to prevent them from falling into Allied hands. The cost of the R.84 to R.86 was 600,000 marks each. These aircraft varied from the Staaken-built R.XIVa machines only in detail, and are described in that chapter.



Schütte-Lanz R-Project 1916

Schütte-Lanz, by virtue of its experience in outfitting airships, also produced engine-room telegraphs (twenty were delivered) and bomb-release mechanisms for other R-plane manufacturers.

In the middle of 1917 the "Amerikaprogramm" came into being, and its execution became the responsibility of Idflieg. The programme's sole purpose was to strengthen the German air arm to meet the expected impact of American participation in the war. Although emphasis lay in the establishment of new fighter squadrons, the complement of the two R-plane squadrons was also to be increased. The net effect on Schütte-Lanz was that it, among other aircraft companies, received a contract to construct two all-duraluminium R-planes, designated the Schül R.I, numbered R.65 and R.66.

Although Dipl.-Ing. Hillmann had left Schütte-Lanz in April 1916, he continued to maintain close contact with Dr. Schütte and participated in the design of the R.I as a consultant. Hillmann recommended that the R.I incorporate the best features of two designs he had prepared for Schütte-Lanz: the central-engined G.IV and the twin-boom, three engined G.VI. As first proposed by Schütte-Lanz designers, the R.I was a rather ungainly aircraft characterized by sharply swept-back wings, a Staaken R.VI gunner's pulpit and cabin, very high and fully enclosed by windows; a biplane tail perched atop the tail booms and a massive combination twin-truck tandem landing gear equipped with an awkward total of sixteen wheels. At Dr. Schütte's request Hillman modified the proposed R.I to give it more pleasing aerodynamic lines.

The final R.I version, again slightly modified by Schütte-Lanz designers, included some features which Hillmann would have changed; namely, the rectangular wing planform and the insufficient rudder surfaces. It was a twin-boom biplane with a centre nacelle containing the pilots' cabin, navigator and wireless operator's positions, the bomb load and six 300 h.p. Basse und Selve BuS.IVa engines, the most powerful six-cylinder engine available for R-plane use at the time. The twin-boom layout was Schütte-Lanz' solution to the central-engine problem. Experience with previous central engined R-planes had shown that large fuselages were not stiff enough to avoid resonance vibrations, bending and twisting. The same could be said of wing-strut or outrigger mounted propeller supports: they had proved to be too flexible to assure fully reliable operation of the drive system. The Schütte-Lanz solution was to divide the fuselage into three parts: a relatively small, robust centre nacelle to concentrate engine and bomb weight in a compact structural framework which also afforded good manoeuvrability; and two outer booms to support the tractor propellers, the tail and the fuel tanks, which were separated from the engine to minimize fire hazard. In an emergency the fuel tanks could be jettisoned, and a gravity tank located in the top wing contained enough reserve fuel to enable the R.I to find a suitable landing spot. The nacelle and booms were built of U- and I-duraluminium profiles, cable-braced throughout and covered with doped fabric.

Most of the 13·2 metre long nacelle was filled with the six Basse und Selve BuS.IVa engines, leaving but 2 metres in the nose for the pilots' and navigator's cabin. Two engine pairs, separated by a catwalk, were located on each side of the nacelle. Each pair drove a tractor propeller through an individual cone-pawl clutch and common right-angle gear drive connected to a heavy transmission shaft leading out to the propeller gear-box. The remaining engine pair was mounted side by side in the nacelle rear and drove a pusher propeller through individual clutches and a common gear-box. Initially two superchargers driven off the centre gear-boxes were to have been supplied, but these were eliminated in the final version. Underneath the engines an enclosed bomb bay was fitted capable of holding a bomb load of approximately 1500 kg.

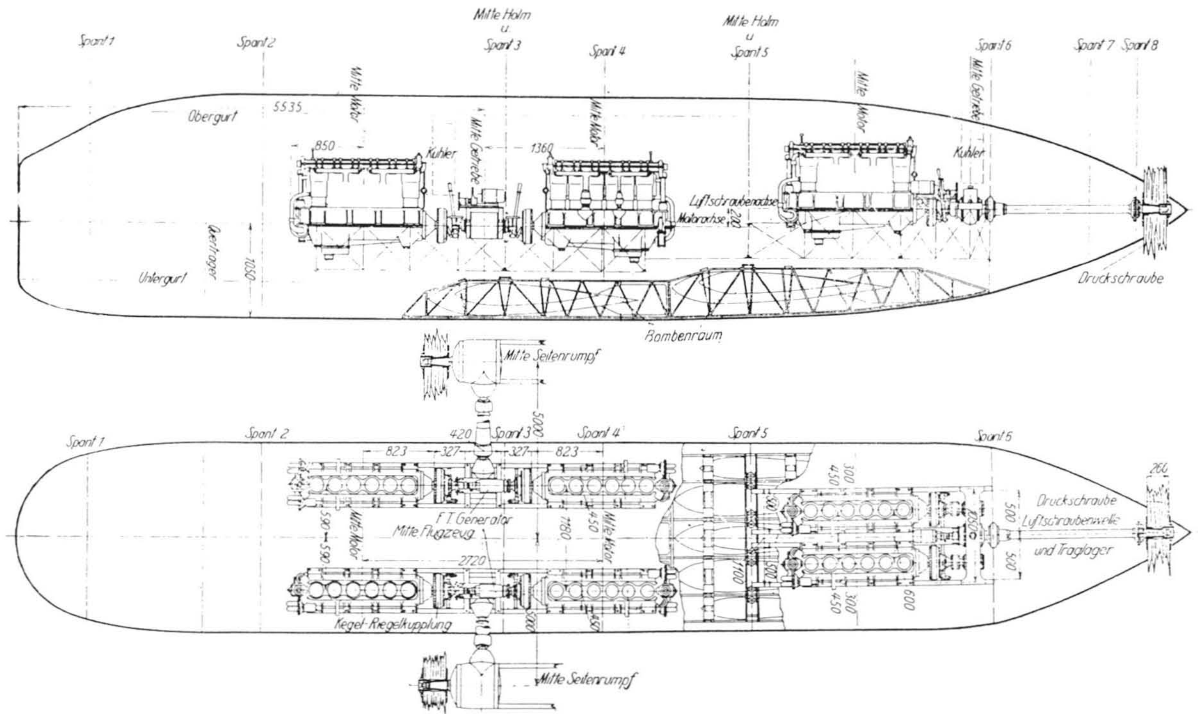
A crew of eight was to have been carried, and five machine-gun positions were provided: a ventral and dorsal turret in each tail boom abeam of the pusher propeller, and a turret in the top wing reached by climbing through a streamlined shaft. If necessary a 3·7 cm. machine cannon could be mounted in the commander/navigator's cockpit in the nacelle nose.

In contrast to the all-steel wing spars employed by Dornier and Junkers, the Schül R.I was the only R-plane to have duraluminium wing spars planned for it. In its airship work Schütte-Lanz had thoroughly investigated the structural properties of plywood, steel and dural profiles and had come to the conclusion that dural was superior, not only for aircraft but also for the last two Schütte-Lanz airships. Spars and ribs of the 44 metre wing were assembled from a combination of tubes and profiles riveted together. Both wings had a 2 degree dihedral and the bottom wing had sharp anhedral inboard of the tail booms, in order to shorten the landing gear and achieve some structural and aerodynamic advantages. Ailerons fitted to both wings were to have been aerodynamically balanced by a "flying" aerofoil or series of "flying" aerofoils suspended betwen the wings and connected in such a manner as to assist working the aileron controls. The device had been tested in a wind tunnel for both aileron and elevator compensation.

The twin booms supported the biplane tail, which, being held at the ends of its span, could be made structurally lighter. An unusual feature of the tail was its three-piece elevator surfaces, a proposed solution to adjusting the angle of incidence of the tail. Fully tested in a wind tunnel, the centre elevator panel was to be used for "coarse" steering during a long climb or descent, while the

two outer panels operated as conventional elevator surfaces to make small corrections. The rudder s fitted at each end of the tapering booms, give an impression of being too small, and it is possible that a third was to be fitted in the centre of the tailplanes.

According to Dipl.-Ing. Hillmann, the R.I was 80 per cent complete when the war ended. It was dismantled to prevent it from falling into Allied hands.

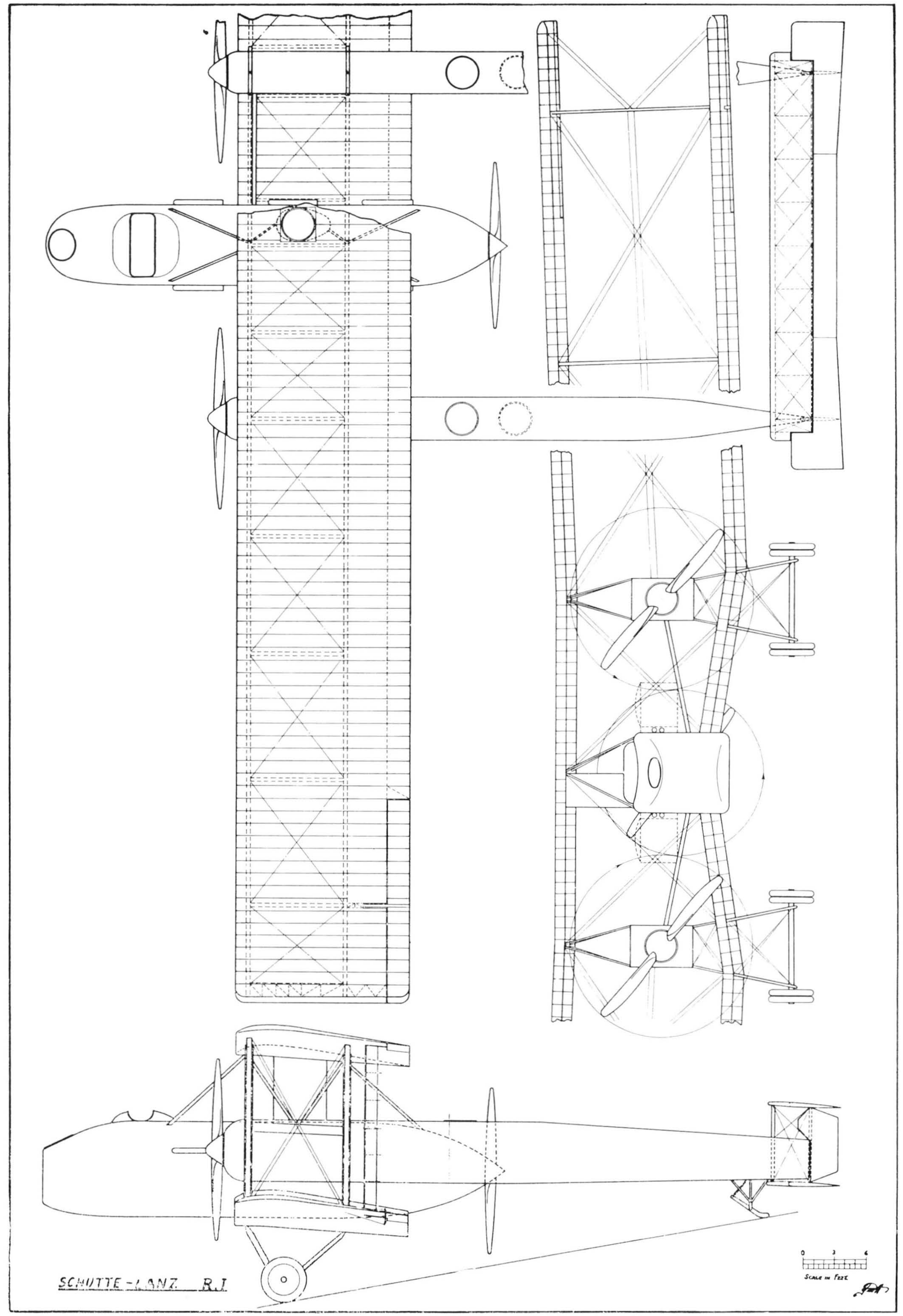


Schütte-Lanz R.I. Engine and power transmission arrangement.

The Schütte-Lanz concern, unlike many of the German aircraft companies, survived the war and the depression. Using the skills it had developed in the processing of plywood and special adhesives for airships, it is today a leading German plywood manufacturer.

SPECIFICATIONS

Type:	Schütte-Lanz R.I
Manufacturer:	Luftschiffbau Schütte-Lanz, Zeesen
Engines:	Six 300 h.p. Basse und Selve BuS.IVa engines
Dimensions:	Span, 44 m. (144 ft. 4 in.)
	Chord, 5 m. (16 ft. 4½ in.)
	Gap, 4·9 m. (16 ft. 1 in.)
	Dihedral, 2 degrees
	Anhedral, 9 degrees
	Incidence, 3 degrees
	Length, 22·97 m. (75 ft. 4 in.)
	Nacelle length, 13·25 m. (43 ft. 5½ in.)
	Boom length, 17·4 m. (57 ft. 1 in.)
	Boom centres, 10 m. (32 ft. 10 in.)
	Height, 7·28 m. (23 ft. 10½ in.)
	Tailspan, 12·9 m. (42 ft. 4 in.)
	Pusher propeller diameter, 4·8 m. (15 ft. 9 in.)
	Tractor propeller diameter, 5·3 m. (17 ft. 4½ in.)



Areas:	Wings, 410 sq. m. (4412 sq. ft.)		
Weights (Est.):	Wings,	2,500 kg.	
	Tail unit,	310 kg.	
	Fuselage,	1,750 kg.	
	Undercarriage,	1,000 kg.	
	Engines,	2,850 kg.	
	Transmission,	990 kg.	
	Propellers,	300 kg.	
	Instruments,	550 kg.	
	Armament,	610 kg.	
	Empty,	10,860 kg.	(23,946 lb.)
	Fuel,	3,260 kg.	(7,188 lb.)
	Disposable load,	2,480 kg.	(5,469 lb.)
	Loaded,	16,600 kg.	(36,603 lb.)
Wing Loading (Est.):	40·5 kg./sq. m. (8·3 lb./sq. ft.)		
Performance (Est.):	Unknown		

Siemens-Schuckert

Unlike many of the other companies, Siemens-Schuckert Werke (SSW) was not a newcomer to the business of constructing aircraft when it began to build R-planes. This great electrical manufacturing concern entered the realm of aviation in 1907 with the construction of a "military" non-rigid airship known as Type M followed by a larger semi-rigid airship that completed a number of successful flights in 1911 and 1912. In 1909 SSW organized a department to undertake the construction of heavier-than-air machines based on the designs of Burkhardt. However, relatively poor performance and mediocre flight characteristics of the several aeroplanes built by the department were responsible for a temporary cessation of activities. In 1914 the aircraft department was reactivated in response to the urgent request for aircraft by the German military forces. A director of the Siemens-Schuckert Dynamowerke, Professor Dr. Walter Reichel, headed the operation and was assisted by engineers Dr. Hugo Natalis, Harald Wolff, Franz and Bruno Steffen, Villehad Forssman, Dinslage, Sander, Von Platen and others. These men were responsible, on one hand, for a remarkable line of single-seat fighters which reached its apex with the fine SSW D.IV of 1918 and, on the other hand, for the construction of the first R-plane to reach the Front.

The Zeppelin-sponsored Versuchsbau Gotha-Ost venture had several months head start when SSW became involved in the first of two R-plane designs in October 1914. The two designs, one by Forssman, the other by the Steffen brothers, were entirely different from each other, but each could be traced back to the influence of the Sikorsky "Ilia Mourumetz" four-engined aeroplane. Forssman was content to copy the Sikorsky configuration almost line for line. Bruno and Franz Steffen, however, used the Sikorsky design in a different manner. It has been written that Bruno Steffen observed the Sikorsky machine first hand while serving as a pilot on the Russian Front. He analysed its disadvantages, which reinforced his belief that the centralized engine design he and his brother started before the war was superior. The brothers reasoned that the engines should be concentrated near the centre of gravity to improve manoeuvrability; be fully enclosed to reduce drag and enable the mechanics to attend the engines during prolonged flights.

Bruno Steffen was in Berlin on his way back to the Front after convalescent leave when, quite by chance, he met his brother Franz, who was on leave after having completed a tour of duty as a pilot on the Western Front. Before the war they had successfully co-operated on various airships and aircraft designs and jointly owned a small aircraft works and school in Neumünster. Taking the opportunity to return to their profession, they visited the Idflieg headquarters in Berlin in an attempt to obtain a production contract for their bomber design. Their ideas aroused much interest at Idflieg, and within a short time they had secured an order for an experimental bomber. Their success

should be compared to the experience of Graf Zeppelin, who, choosing to proceed without military sanction, was placed in an awkward position *vis-à-vis* the military authorities (see Staaken chapter).

The Steffen aircraft works in Neumünster near Kiel were founded in 1908. The brothers' first venture was a small airship, followed by a series of heavier-than-air machines, one of which, the Falke II, was piloted by Bruno Steffen when he broke the German endurance record in 1913. But now the lack of capital, facilities and equipment prompted the brothers to relinquish thoughts of using their works in Neumünster, and they concluded arrangements in December 1914 for SSW to construct the bomber. The brothers joined the company and work began immediately.

The first SSW bomber, later known as the R.I, made its maiden flight in May 1915. It was the prototype for a series of R-planes which enjoyed a long and active career throughout the war.

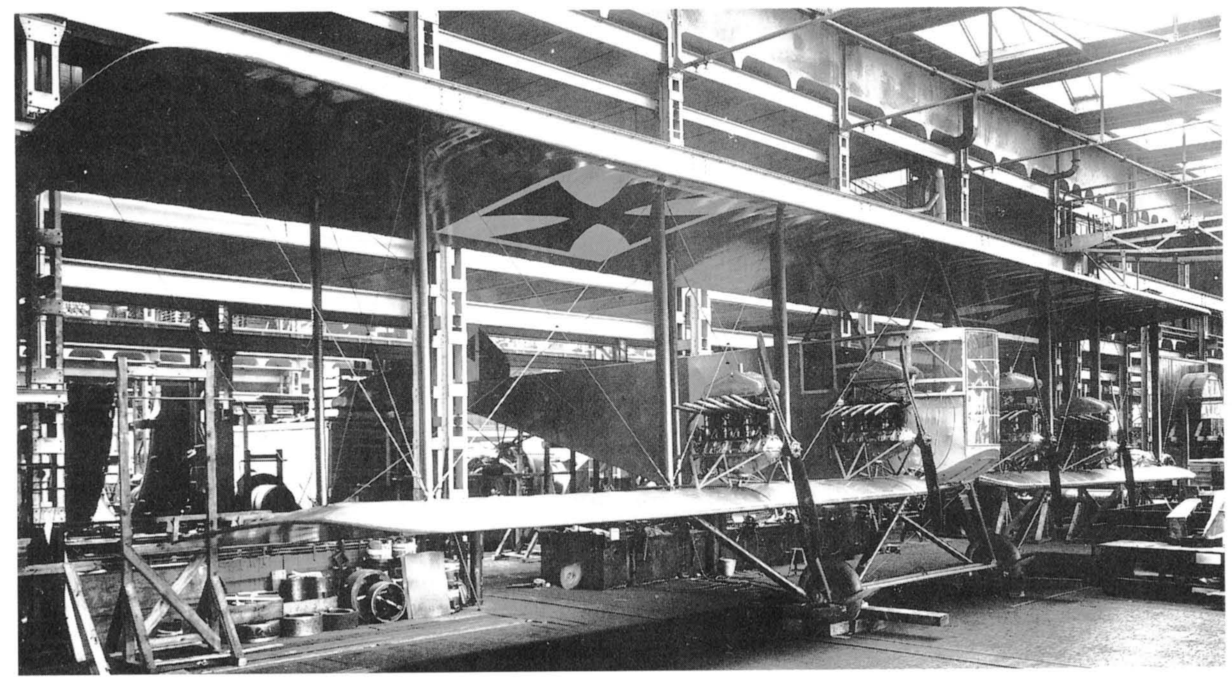
Siemens-Schuckert Forssman "R"

In contrast to the successful Steffen-designed R-planes, the Forssman R was doomed from the start to be a failure, despite the fact that it was modified at least five times to improve its performance. The final version of the Forssman R was the result of such extensive reconstruction that its appearance bore little resemblance to the original.

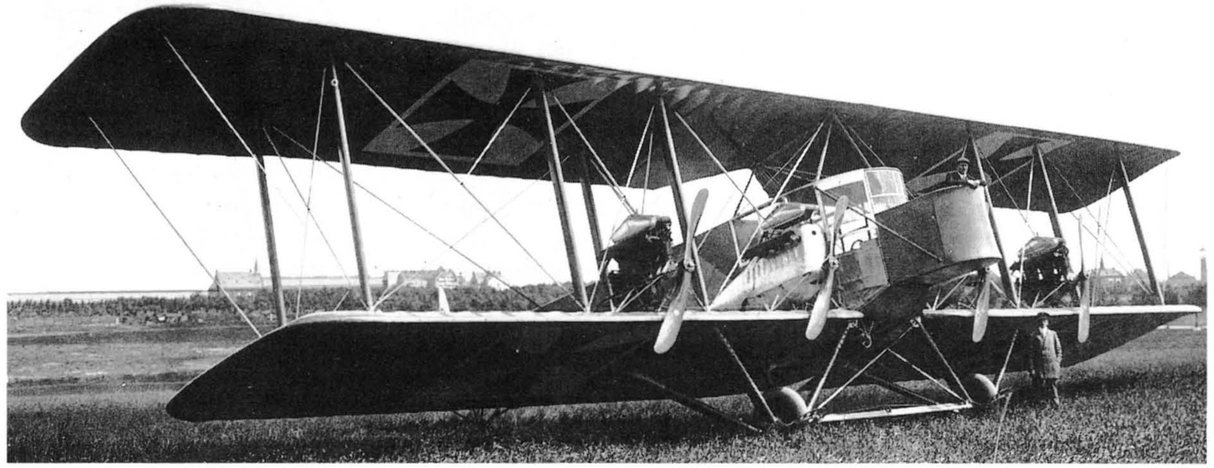
Villehad Forssman, a Swede, made his first appearance as a builder of airships in Russia during the years 1910–12. He then moved to Germany, where he designed and built the "Bulldog" monoplane for Prince Friedrich Sigismund in early 1914. Forssman has been described as a "Jules Verne type", a man with a vivid imagination who invented among other things a one-man submarine, a shell-proof tank and was responsible for the design of the ambitious transatlantic "Poll" Giant project.

At the outbreak of hostilities Forssman joined SSW to construct improved versions of his "Bulldog" monoplanes, which were, however, rejected by the military services due to their overall poor performance and handling characteristics.

It is entirely possible that Forssman had an opportunity to examine early versions of Sikorsky's four-engined aircraft during his Russian sojourn; at any rate, the Forssman R was a rough copy of



The SSW Forssman "R" in its original form before leaving the workshop.

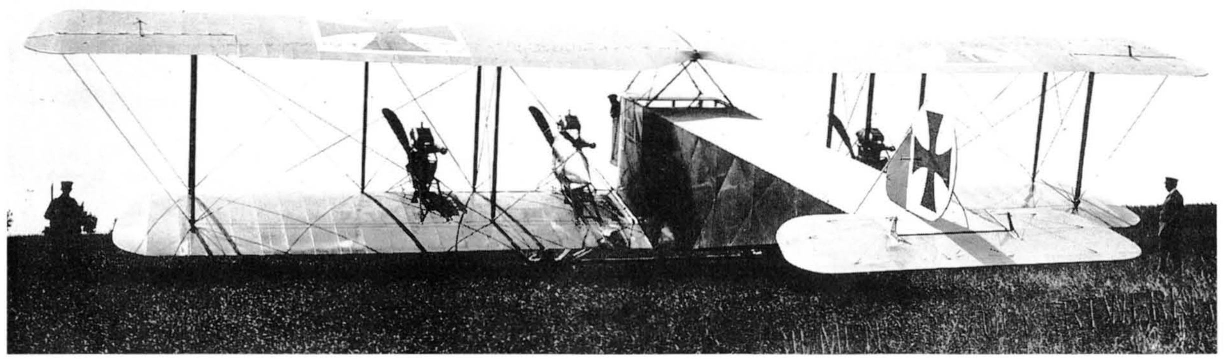


The SSW Forssman "R". The absence of any centre-rear interplane struts is noticeable in this view.

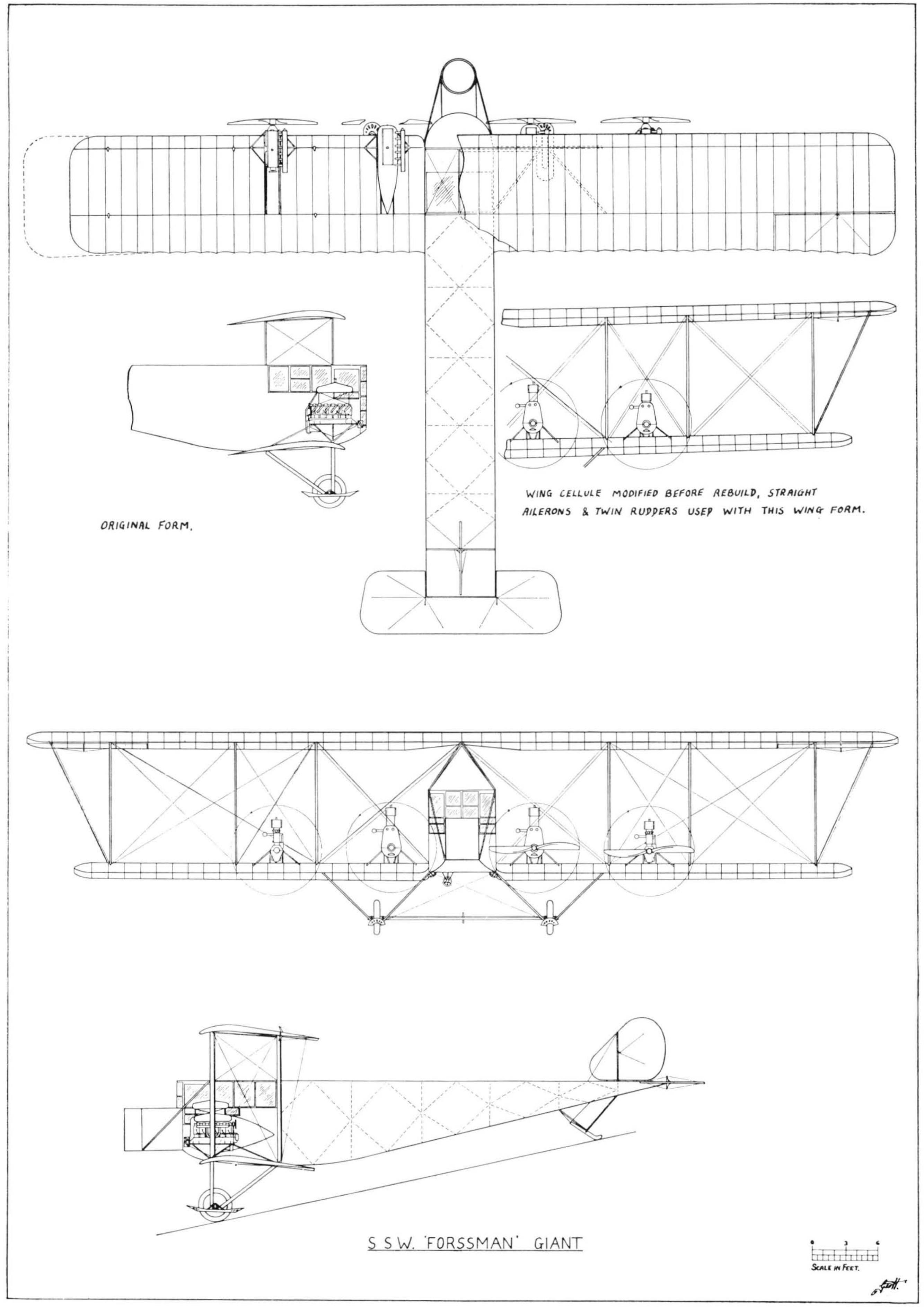
Sikorsky's famous design. The construction of the Forssman R was begun in October 1914, and it was completed some time in the first half of 1915.

In its original form the aircraft mounted four uncowled 110 h.p. Mercedes engines spaced along the lower wing, each of which drove a single tractor propeller. The pilots' cabin was located in an abbreviated nose that was amply supplied with transparent panels for a magnificent view. Early flight tests, believed to have been limited to short exploratory hops, revealed a serious lack of fore-and-aft trim. This required additional weight in the form of an observer/gunner's pulpit fitted to the nose, and this was crudely braced by a strut running from the pulpit floor to the top longerons. The wings were rigged in a peculiar fashion—instead of a pair of struts between the second and third bays, only a single front strut was fitted. Tests proved this arrangement to be unsatisfactory, and the missing strut was added along with diagonal struts to support the overhang of the upper wing. Modification followed modification. The large side area of the fuselage and its relatively short-moment arm required the addition of another rudder to improve control. The wings were also re-rigged with slight dihedral to improve lateral stability.

Besides being structurally weak, although some parts, such as wing struts and landing gear were far too strong, the handling qualities of the Forssman R were notoriously bad. In addition, the aircraft was underpowered, and it is doubtful if any flights other than short hops were attempted. One wonders how the speed of 115 km.h. claimed for this version was arrived at. In any case, the Forss-



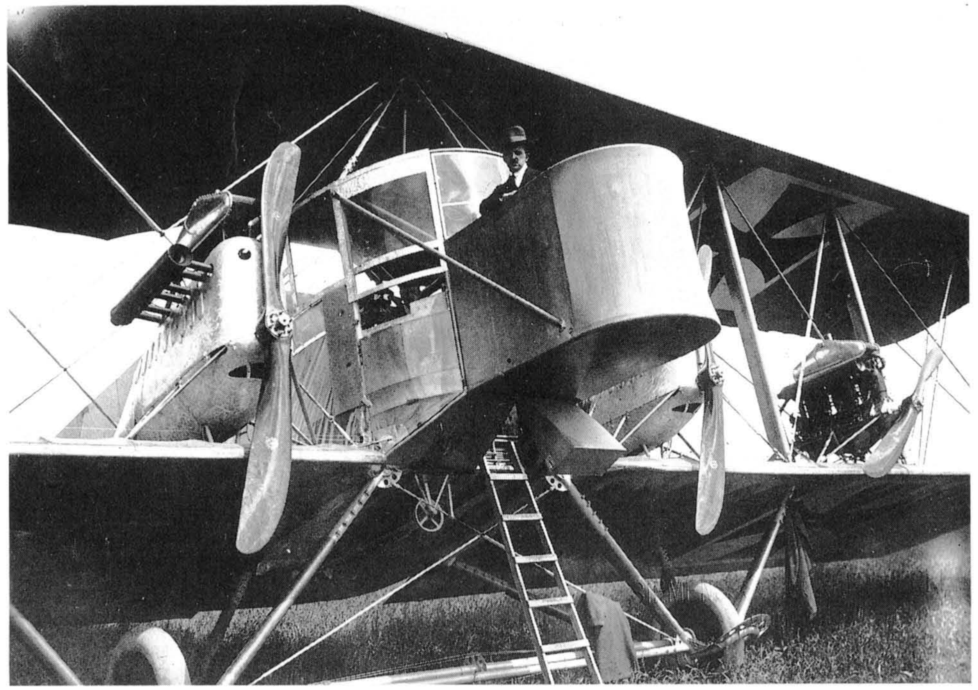
SSW Forssman "R".



man R was in no condition to fulfil the Idflieg acceptance specifications. By this time, Villehad Forssman had severed connections with SSW owing to the failure of his design.

In an attempt to make something of the machine, it was extensively modified by Harald Wolff and fitted with higher-powered inboard engines. These were mounted on a strengthened and faired structure. The original outer engines were retained, but to improve propeller efficiency they were raised to mid-gap position supported by the faired second-bay wing struts. As before, the engines were fully cowled, but the propellers were fitted with spinners.

To improve streamlining, the fuselage nose was rebuilt to a sharp point. It was fitted with incongruous bull's-eye windows and surmounted by a fully-enclosed teardrop-shaped pilot's cabin. The fuselage was given openings for gun positions in the nose ahead of the cockpit, in dorsal and in ventral locations. There is no evidence of machine-gun rings having been mounted.

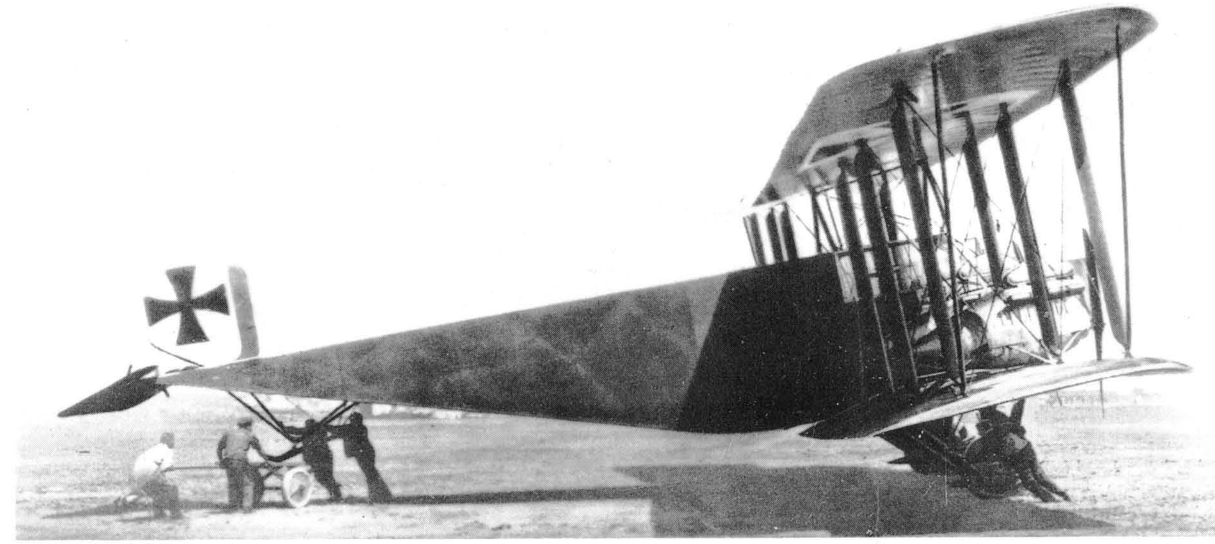


SSW Forssman 'R' fitted with nose pulpit position and showing method of entry into the machine.

After one pilot declined to fly the machine following a few ground runs, the famous pre-war pilot and later Pour-le-Mérite holder, Lt. Walter Höhndorf, decided to make an attempt. In September 1915 he took the controls, and it is said that he made a short hop (or two) when the machine capsized during a landing run. The Forssman R turned almost completely over, coming to rest on its crushed nose and upper-wing leading edge, which was neatly fractured spanwise in the process.

Reluctant to write off their ever-increasing investment in the machine, SSW once again rebuilt the Forssman R in hopes that it would finally be accepted by Idflieg. As the crash had not been too serious, it was a comparatively simple matter to fit a new nose and repair the wing. The nose was rebuilt into a rounded, blunt shape fitted with a circumferential window. An opening for a future gun position which remained covered for flight trials was located atop the nose. The pilots' cockpit was either situated behind the window or in an open position under the leading edge of the wing. Outwardly these represented the only major changes. In its final form the Forssman R, with its modern glassed-in nose, fully cowled engines and handsome paint job, presented a sleek appearance which belied the weakness the gloss concealed.

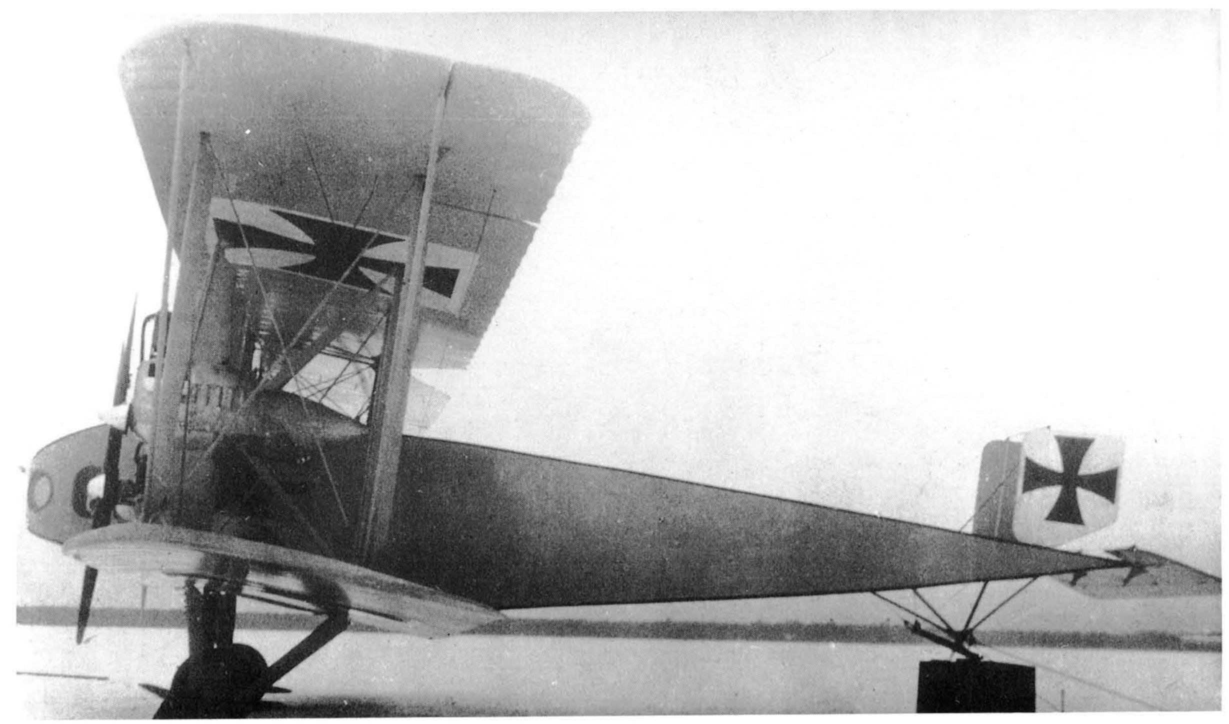
By this time, the Forssman R had achieved a universally bad reputation, known as the *Ladenhüter*, freely translated as "White Elephant". No pilot could be found to fly the machine. Consequently,



The SSW Forssman "R" fitted with twin rudders.

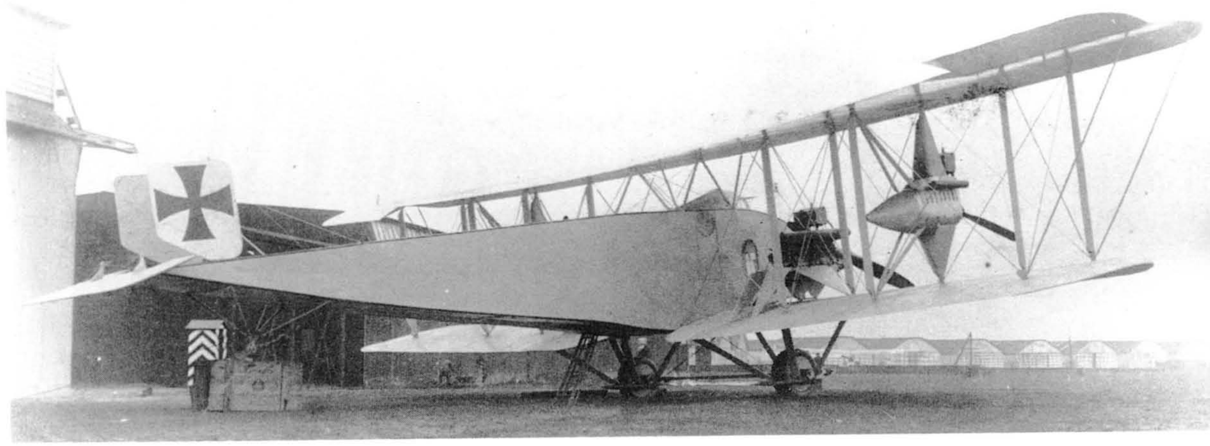
for the major part of its life the Forssman R sat in a great hangar at Johannisthal collecting dust and taking up valuable space while damaging the prestige of SSW. But the aircraft belonged to SSW, and they understandably were anxious to deliver it to the military services and in turn recapture a portion of their investment.

The technical director of the SSW aircraft section, Dr. Reichel, approached the Steffen brothers and offered them 10 per cent of the delivery price if they would perform the acceptance flight. In return for a price reduction, Idflieg reduced the delivery specifications, which now called for the machine to reach 2000 metres in 30 minutes carrying a useful load of 1000 kg. and enough fuel for



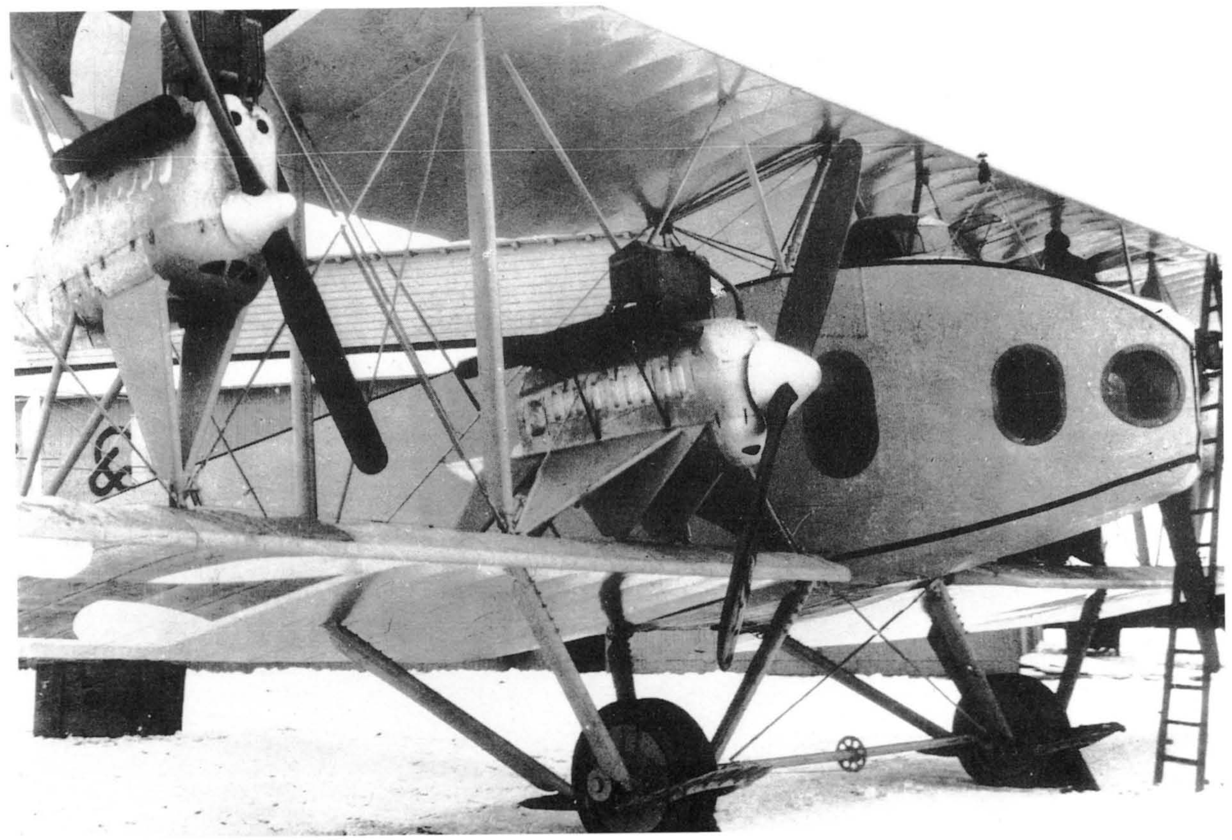
The SSW Forssman "R" in its re-designed form, 29 October 1915.

M

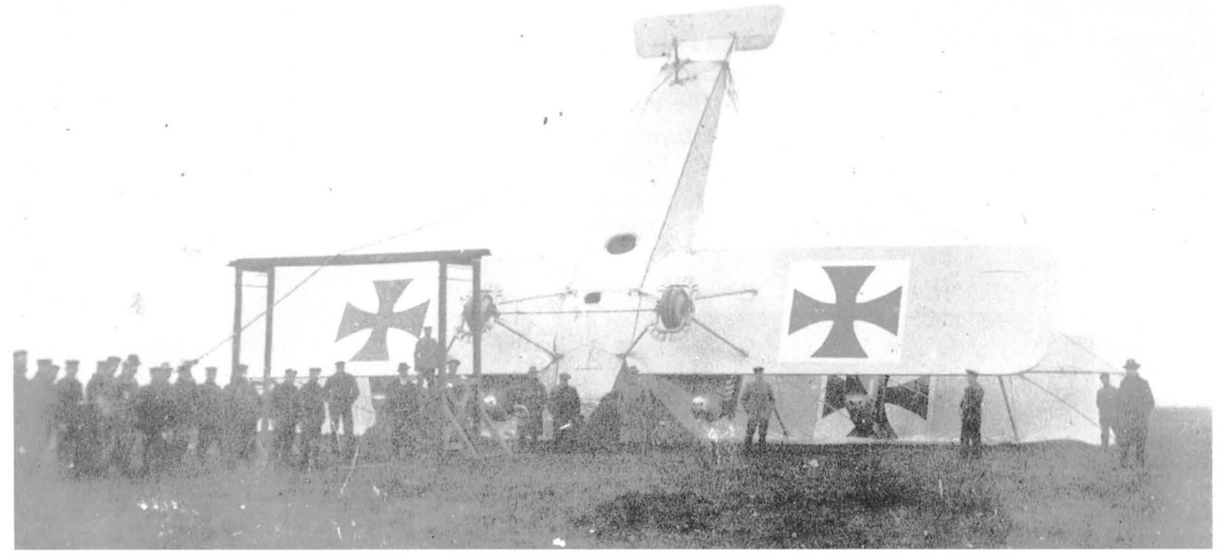


Re-designed SSW Forssman "R".

4 hours. Bruno Steffen accepted the challenge, but only after thoroughly convincing himself that the Forssman R was reasonably safe to fly. The tail surfaces were so large that he feared he did not possess the strength to move them. He considered the landing gear and wing struts far too robust, whereas other parts appeared too weak. One change which he made was to install a device so that all throttle levers could be operated in unison when necessary. Steffen felt that the lack of this feature was the reason why other pilots had such poor luck trying to fly the Forssman R. Meanwhile, Franz

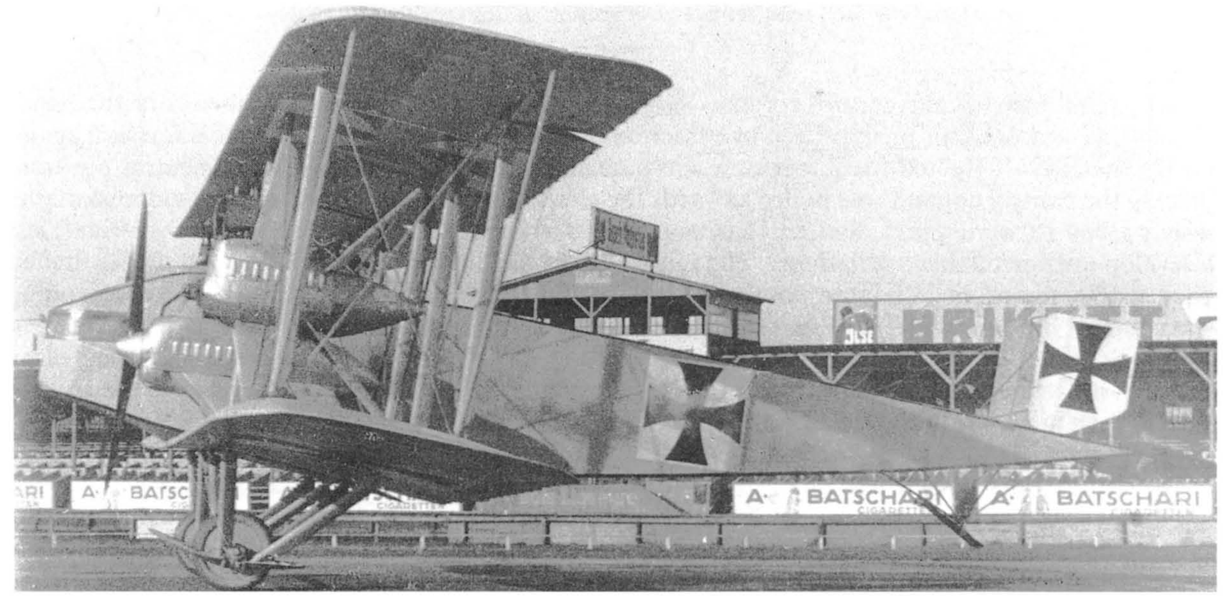


Engine nacelles and nose of the re-designed Forssman "R".



SSW Forssman "R" crashed after a test flight by Lt. Höhndorf.

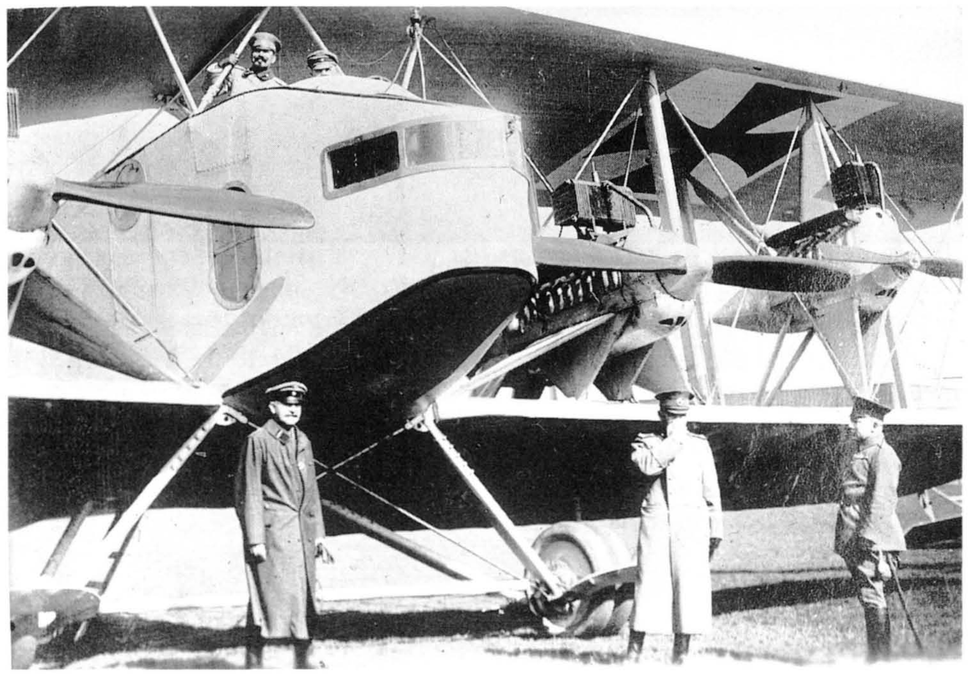
Steffen had carefully studied the construction drawings and the engineering calculations. He concurred with his brother that the aircraft was safe and strong enough to fly, but warned him that the fuselage immediately behind the wings was dangerously weak, and that caution must be taken during landing and taxying. Everything considered, Bruno decided to perform the acceptance flight despite final warnings from his associates and friends. All that remained was to convince himself that he could control the machine in the air, and he prepared to make a short test hop. He found the steerability on the ground good by alternately revving opposite outer engines. After a hop of 300 metres he landed, satisfied that he could control the aircraft in the longitudinal direction at least. Although the hand-wheel control column was massive and the ailerons huge, he did not think he would experience any difficulties, for he felt he could always maintain lateral control by means of throttling the outer engines. All was ready for the acceptance flight in October 1915.



The SSW Forssman "R" in its final form taking-off at Johannisthal.

Steffen decided to fly the Forssman R on the next day with five persons aboard as he had in the SSW R.I. But everyone whom he invited to go along, including members of the Idflieg acceptance commission, politely declined, leaving him no choice but to fly alone. For the flight, the Forssman R carried 725 kg. ballast and 275 kg. extra fuel to make up the required 1000 kg. useful load.

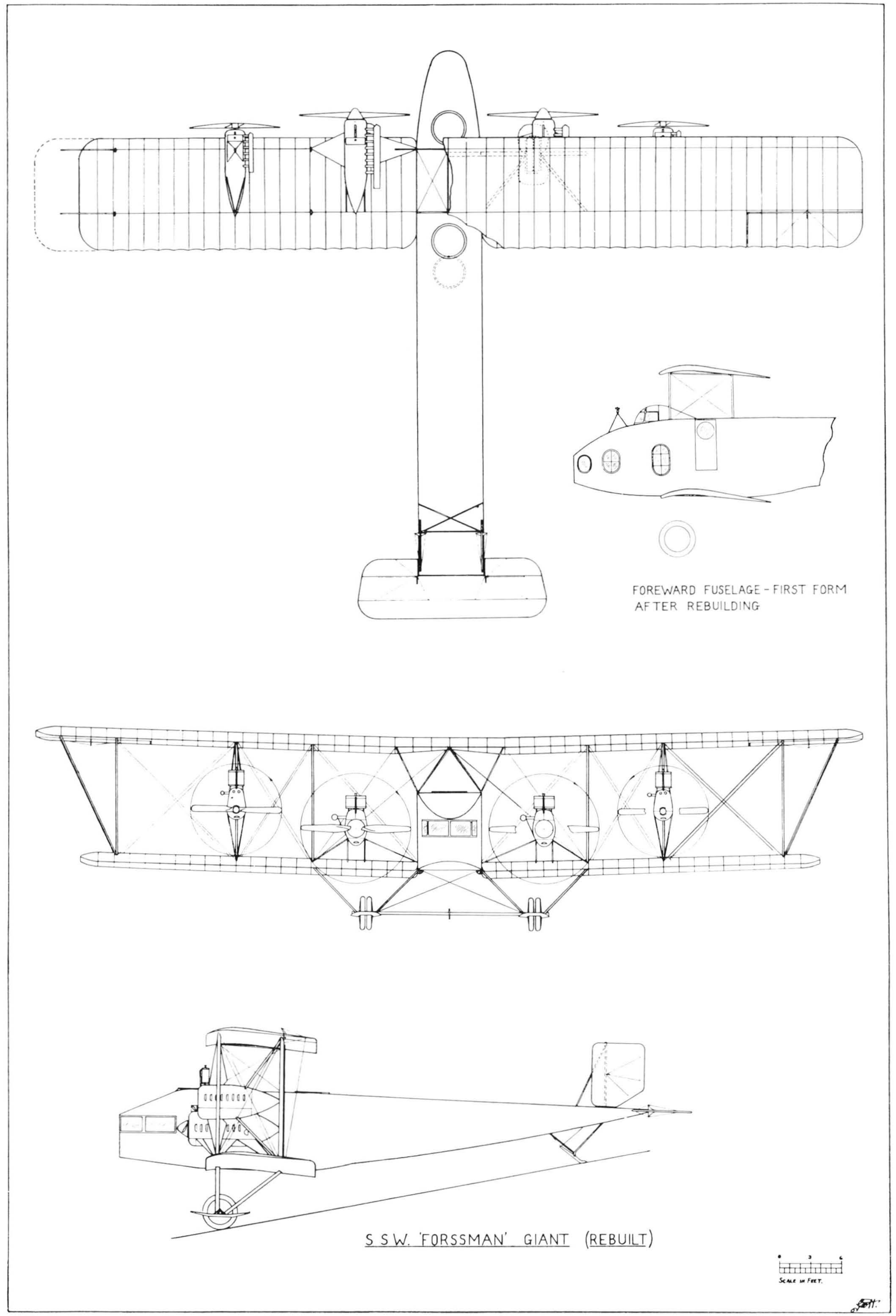
Once in the air, he found the loaded aircraft tail heavy, which so increased the angle of attack that there was a danger of stalling. He was able to achieve correct climbing trim with the hand-wheel control column pushed far forward, a position which normally should have caused an aircraft to descend. During the flight, Bruno Steffen experienced only one updraft, but a violent one which threw the machine into a bank. With the control column held far forward, Steffen did not have the strength to turn the hand-wheel to correct the bank with the ailerons. Although in a climb, he was

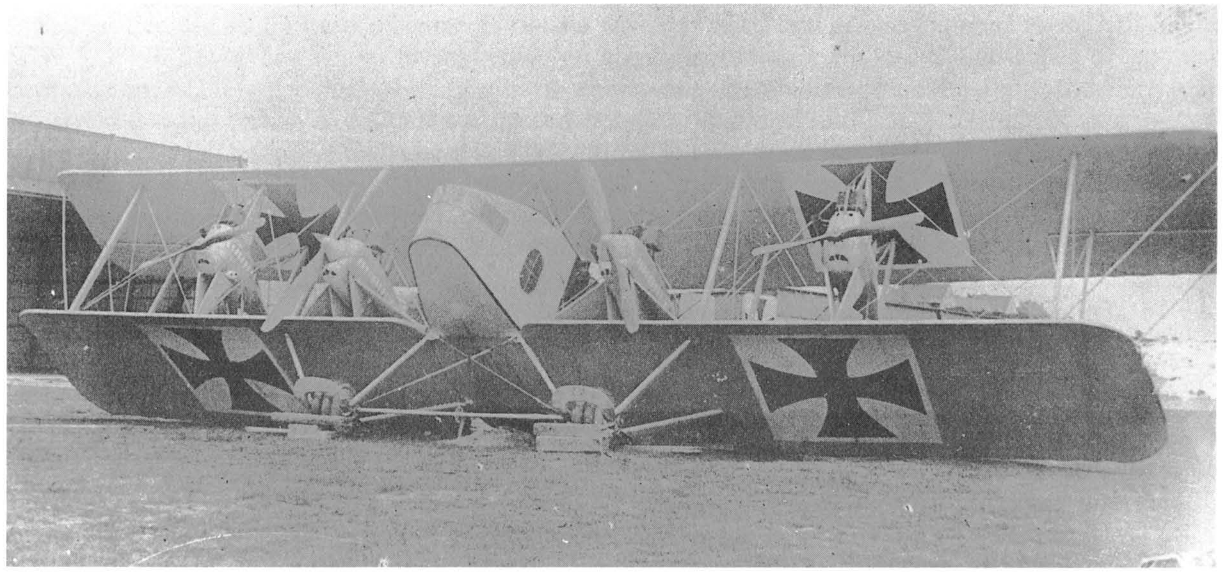


The SSW Forssman "R" with rebuilt nose section at Johannisthal airfield.

forced to pull back on the control column, causing the machine to nose up and then turn the hand-wheel—one and one-half turns! Then in a fraction of a second he pushed the controls forward again. Slowly the aircraft righted itself, but now the time came to return the ailerons to neutral position. Quickly the control column was pulled towards the chest, the hand-wheel was turned and instantaneously pushed forward again. Steffen knew that he had to maintain absolute control of the aircraft lest it develop uncontrollable oscillations. The remainder of the flight was uneventful, and Bruno Steffen reached 2000 metres in 28 minutes, but to be sure he climbed another 100 metres. He was descending when one of the outboard motors stopped, through lack of fuel-tank pressure. Steffen pumped vigorously, but to no avail, and shortly all engines stopped. Steffen, who had experienced many close shaves in five years of flying, felt that this time his luck had finally run out. But by pushing the control column even farther forward, and half out of his seat, he was able to maintain a reasonable glide angle and managed to land safely. The ballast and fuel were weighed, and the barometer checked, with the result that the Forssman R was finally accepted by Idflieg in April 1916 for training use. All further development of the design was stopped. Later on the ballast or useful load was relocated to balance the tail-heavy condition but the machine was still next to impossible to fly.

Shortly after the aircraft's acceptance the fuselage broke in two (just aft of the wings) due to vibrations while running the engines on the ground. The Forssman R was dismantled. Bruno Steffen





The SSW Forssman "R" after breaking its back.

was glad when he heard the news, for now the danger that the machine could crash and claim human lives was past.

The Forssman R was constructed before the R designation was actually applied to large aircraft. Consequently, if it did have a designation the Forssman R probably fell into the G category. Later German records refer to the machine as the Forssman R, although strictly speaking, it did not meet the R specification that the engines must be serviceable during flight.

The Forssman R did not add anything to the development of the R-plane as a fighting weapon nor as an aircraft. It was a misconceived design from the start, and perhaps its only contribution to R-plane history was that it gave engineers an opportunity to learn from a failure.

Colour Scheme and Markings

The original aircraft had an overall dull buff appearance. Large Patée crosses on white backgrounds were painted on both sides of the upper wings and on the underside of the lower wings at half-span position. Similar markings were applied to the rudders. The redesigned version was painted a light colour and the edges of the fuselage were outlined in black.

SPECIFICATIONS

Type:	SSW Forssman R (first version)
Manufacturer:	Siemens-Schuckert Werke G.m.b.H., Siemensstadt, Berlin
Engines:	Four 110 h.p. Mercedes engines
Dimensions:	Span, 24 m. (78 ft. 9 in.)
	Length, 16·5 m. (54 ft. 2 in.)
Areas:	Wings, 140 sq. m. (1506 sq. ft.)
Weights:	Empty, 3250 kg. (7166 lb.)
Performance:	Maximum speed, 115 km.h. (71·5 m.p.h.)
Service Use:	None

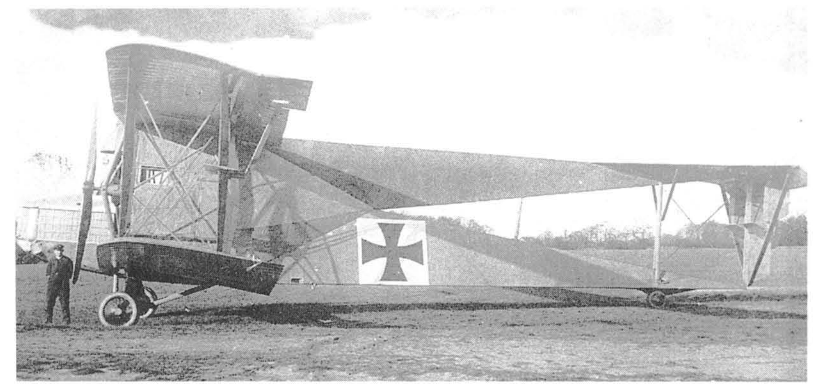
SPECIFICATIONS

Type:	SSW Forssman R (second version)
Manufacturer:	Siemens-Schuckert Werke G.m.b.H., Siemensstadt, Berlin
Engines:	Two 220 h.p. Mercedes D.IV engines
	Two 110 h.p. Mercedes engines
Dimensions:	Span, 24 m. (78 ft. 9 in.)
	Length, 16·5 m. (54 ft. 2 in.)
Areas:	Wings, 140 sq. m. (1506 sq. ft.)
Weights:	Empty, 4000 kg. (8820 lb.)
	Loaded, 5200 kg. (11,466 lb.)
Performance:	Maximum speed, 120 km.h. (75 m.p.h.)
	Climb, 2000 m. (6562 ft.) in 28 mins.
Service Use:	Training duties

SSW R.I

In December 1914, after the agreement between SSW and the Steffen brothers was concluded, work began on the Steffen centrally-engined design eventually to be known as the SSW R.I 1/15. Because adequate space and man-power were available, it was decided to employ the facilities of the SSW-Dynamowerk in Berlin, and throughout the war this location remained the centre of SSW R-plane activities. Work on the R.I proceeded swiftly, so that in early 1915 it was possible to ship the component parts to Neumünster for assembly. The Neumünster location was picked to keep the existence of the R.I secret, at least until after initial test flights.

The SSW R.I was the prototype of the Steffen-designed SSW R-planes, of which a total of seven were built. Later machines had the same configuration and differed only in size and detail. The R.I was the first German R-plane equipped with internally or centrally mounted engines. Although the Steffen brothers developed the central-engine concept prior to the existence of Idflieg R-plane specifications, it represented another solution to the problem of servicing the engines in flight.



SSW R.I 1/15.

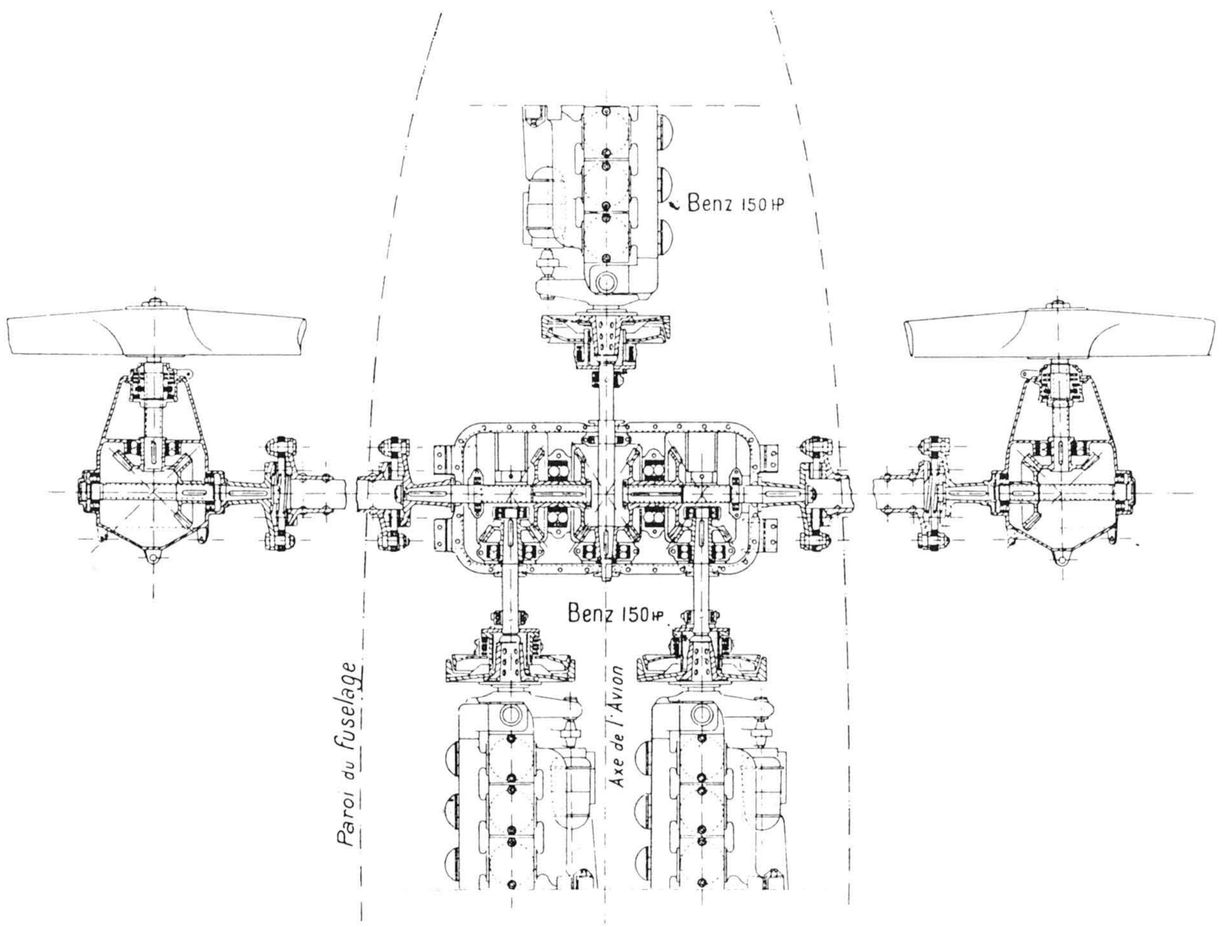
The three 150 h.p. Benz Bz.III engines chosen to power the R.I were mounted on engine bearers which formed a foundation for the forward fuselage section. Two engines were placed side by side in the extreme nose with their crankshafts facing aft. Each engine was connected to a common gear-box through a combination leather-cone and centrifugal-key clutch. The third engine, similarly connected, was mounted behind the gear-box on a lower level and facing forward. The purpose of the leather-cone clutch was to friction-start the propellers from a standing position. As soon as a certain number of revolutions were reached, the centrifugal-key clutch engaged automatically and the leather-cone clutch was disengaged by the mechanic. If an engine were to slow down or stop the centrifugal clutch would automatically decouple below a certain minimum number of engine revolutions. The common gear-box was designed for minimum weight using the lightest possible gears. As a result, the gear-tooth pressures were fairly high. Although difficulties were experienced with the clutch system, the gear-box proved to be reliable and trouble-free when carefully serviced and attended in all of the Steffen-designed R-planes.

Two transmission shafts transferred the power from the gear-box to the propeller gear housings mounted on struts between the wings. Vibrations and misalignments were compensated by laminated spring couplings and universal joints.

Three slab-shaped radiators composed of a series of small tubes were fitted around the nose of the machine.

Externally the R.I and its successors possessed one unmistakable feature: a curious forked fuselage formed by two triangular, tapering tail booms. This configuration allowed a wide field of fire to the rear from beam-mounted machine-guns; although in the R.I the gun openings were panelled over. In 1916 SSW was granted a patent for a novel device to change the angle of incidence of the tail. By means of a large hand-screw the distance between adjacent apexes of the tail-boom triangles could be adjusted, resulting in a lowering or raising of the tail. This feature, however, was not employed, and it has not been determined to what extent it influenced the designers to use the split tail structure.

The fuselage completely filled the wing gap and descended abruptly at the wing leading edge to form a very high pilot's cabin commanding a fine view. At first the cabin was open, but later Cellon panels were fitted to the sides and top of the opening. The pilots' seats were situated above the central gear-box, and the third engine was located deep within the fuselage surrounded by two



SSW R.I. Engine and power transmission arrangement. (The engine layout is here shown reversed.)

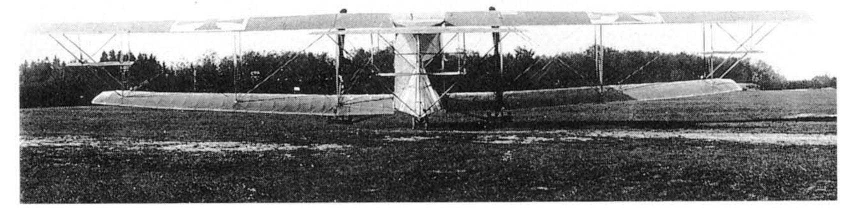
horizontal, cylindrical fuel tanks. Possibly the open cockpit enclosure provided a means for flushing out vapours and heat generated by the buried engine. The clutch levers were mounted between the pilots, but on later machines the clutch was operated by the engine mechanic.

An upper gun position, located above and behind the pilots, consisted of an enclosed platform provided with a small access door. The R.I was delivered to early Idflieg specifications that called for

200 kg. armour for pilots and engines, but this requirement was dropped by Idflieg on 21 August 1915.

The fuselage was constructed of wire-braced steel tubing covered with fabric, except in the nose section, where some duraluminium panels were applied.

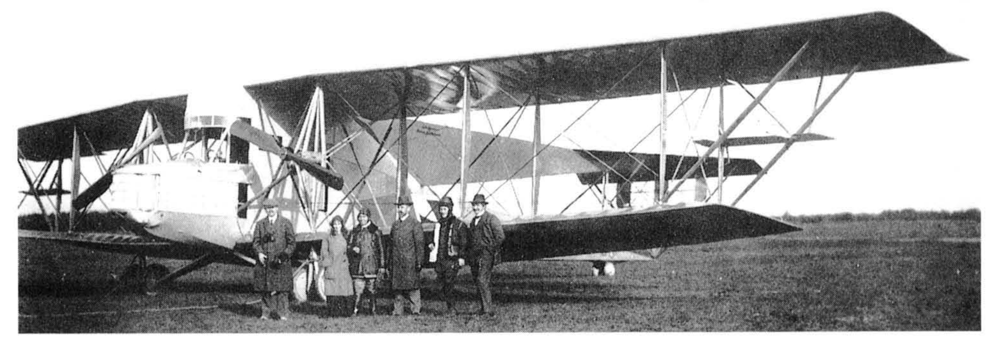
The three-bay wings were built entirely of wood with the exception of the internal wire bracing and the metal compression tubes between the spars. Ailerons were mounted on the upper wings only, but contrary to common practice, the controls actuated a small aerodynamic balancing surface mounted between the wings, which in turn controlled the ailerons.



SSW R.I 1/15.

A strut-braced triangular tailplane fitted with a one-piece elevator was affixed to the upper "prong" of the forked tail. The elevator was assisted by divided aerodynamic balancing surfaces in the same manner as the ailerons. The rudder was mounted between the "prongs" and was balanced by being hinged behind its leading edge and by small balancing surfaces.

The two separate undercarriage units consisted of a pair of wheels attached to two inverted V-struts which were fixed to the front and rear wing spars. A diagonal tube from the axle braced the undercarriage to the fuselage. The wheels were sprung by rubber shock cords, but an ingenious spring-loaded double bell-crank device was also tried on the R.I. A small pair of steerable tail wheels took the place of the more usual tail skid.



SSW R.I 1/15 at Neumünster, May 1915. From the left—Karl Friedrich von Siemens, Franz Steffen and wife, Dr. Walter Reichel, Bruno Steffen and Dipl.Ing. Dinslage.

Only a handful of men had flown aircraft with more than two engines when Bruno and Franz Steffen climbed behind the controls of the R.I to guide the machine on its maiden flight. It was a totally new experience for both men, and not knowing what to expect from such a large craft, their minds whirled with unanswered questions. However, as Bruno Steffen recalls, within a few minutes after taking off, they knew the R.I was a sound craft; it "sat" well in the air and showed no heaviness in any direction. Besides the tachometers, the brothers maintained a sharp watch on the gear-box thermometers, which were climbing at a rapid rate. For safety's sake, they decided to land. The R.I, weighing 5 tons, landed with surprising ease, and as it rolled to a stop, Bruno and Franz Steffen looked at each other and smiled with relief. All previous anxieties of landing the heavy aircraft, a cause of worry to both men, had disappeared. This maiden flight took place on 24 May 1915.

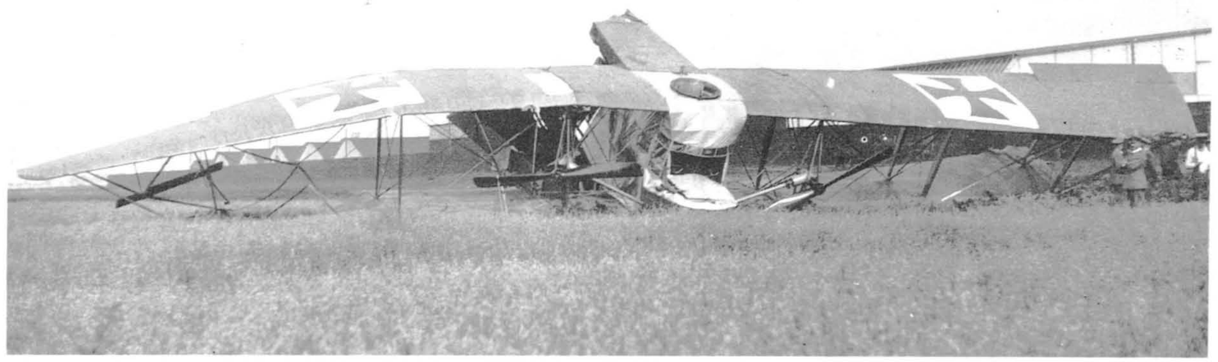
The SSW R.I modified by having windows fitted around the control position.

The gear-box was dismantled to seek the cause for the overheating of the oil, and it was ascertained that the oil was too viscous to lubricate the gear teeth properly. The remedy consisted of installing a forced-circulation system and using a thinner grade of oil.

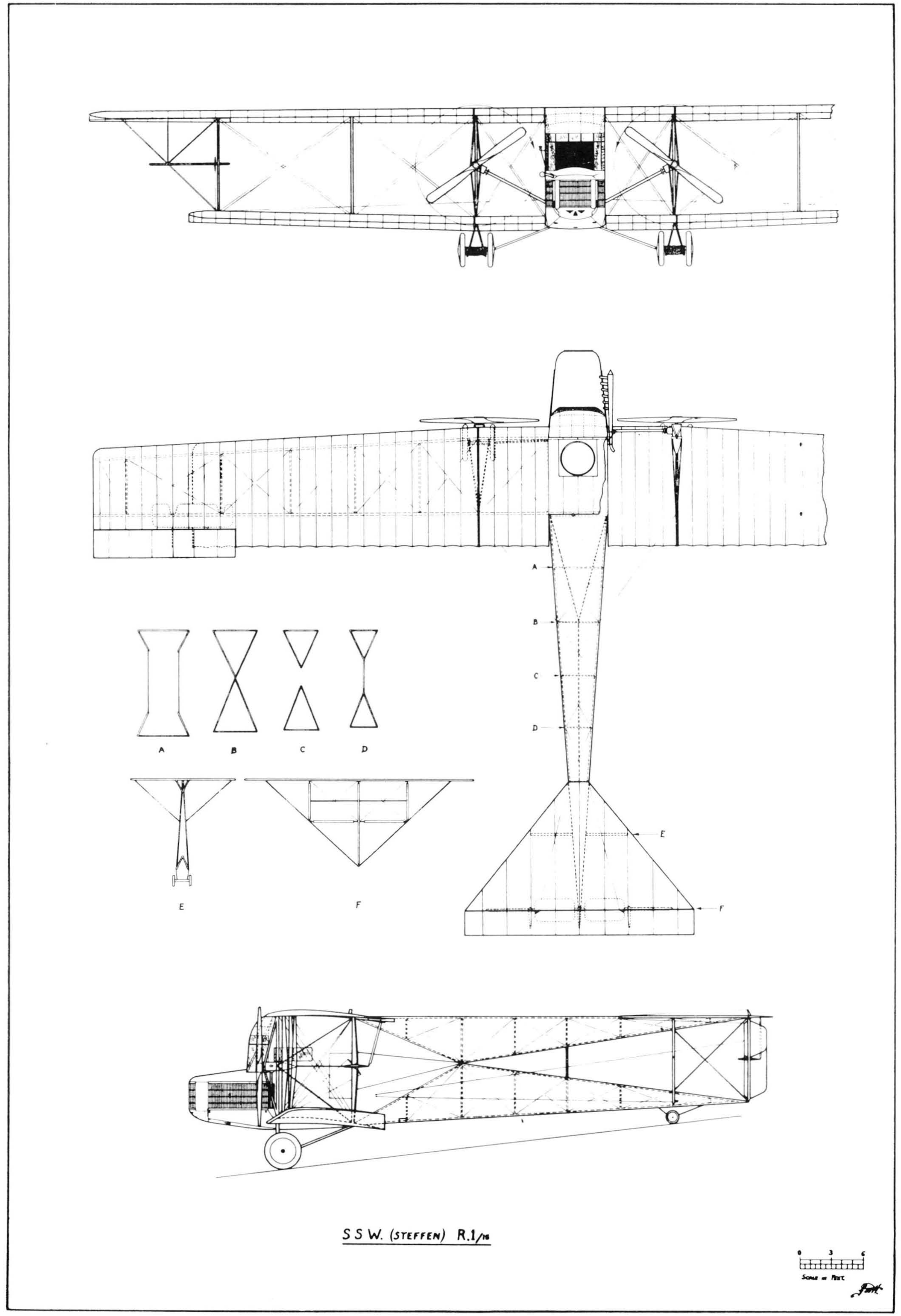
Next, a number of calibration flights were made to discover what the R.I could do. These embraced altitude flights made with varying loads, and in the final flight of the series the R.I reached an altitude of 3700 metres in 45 minutes carrying the specified load of 1200 kg. During speed trials at an altitude of 10 metres over a 5 km. course, a top speed of 128 km.h was measured with full load.

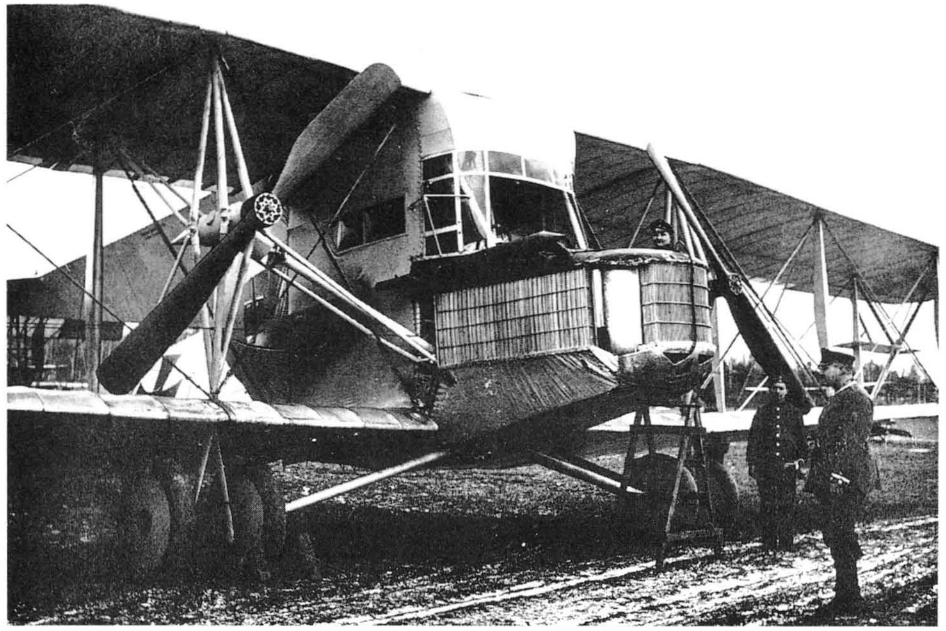
One weakness discovered in the course of testing the R.I was the repeated failure of the propeller drive system due to vibration. In fact, a universal joint did snap at the far end of the transmission shaft. The engines were stopped in the nick of time to prevent the flailing shaft from causing fatal damage. The vibration problem was solved by adding stiffener tubes fore and aft of the transmission shafts. Other minor modifications were made to prepare the R.I for final acceptance flights.

These flights took place some time in June 1915, and the three-man Idflieg acceptance commission arrived at Neumünster to participate in a combined acceptance deliver flight. Bruno Steffen, as pilot, had purposely kept 600 kg. free in hopes of being allowed to carry seven passengers (some sources say nine). His wish was granted, and after the useful load and passengers were weighed and verified, the R.I took off for Döberitz. Steffen had placed two light armchairs in the cabin and hidden a bottle of champagne in a corner.



Crash of the SSW R.I 1/15 after engine failure at a height of 8 metres in August 1915.





The SSW R.I with strengthened transmission system. This took the form of additional tubes on either side of the driving shaft.

After take-off his sole attention was fixed on reaching the acceptance altitude in the specified time, not an easy task in the sultry and bumpy summer weather. As he fought to achieve altitude, he noticed clouds and lightning ahead over Lübeck. This did not escape the acceptance commission, who asked Steffen to please avoid the storm. Steffen answered that he was very sorry, but he had to achieve the required altitude. In a short while the answer came from the commission, who stated that they could see from the barograph that the R.I would reach the altitude in the specified time and therefore it was not necessary to do so . . . but to please avoid the storm.

The trip to Döberitz was smooth, and after the champagne cork was popped the atmosphere aboard the R.I became positively gay. Bruno Steffen remembers the surprised look on the faces of the officers and flyers who greeted the R.I at Döberitz as one passenger after another deplaned with their luggage.

The R.I made some twenty-four test flights prior to delivery to the military services. During one of these the R.I made an emergency landing at Neukölln with Lt. Höhndorf at the controls (15 July 1915). The reason was engine trouble, but the R.I managed to take-off again in the evening. It was delivered to the air services on 26 July 1915.

A little-known fact is that the R.I was initially ordered as a G-type aircraft and was designated as the SSW G.I 31/15. On 13 July 1915 the designation was changed to G.I 32/15, and this was again changed to its final designation, R.I 1/15, on 6 November 1915.

Shortly after its delivery, the R.I was on a training flight piloted by Oberleutnant Krupp and Feldwebel Hebart with Bruno Steffen aboard as instructor when it crashed at Johannisthal. It had barely taken the air when one engine after the other failed, forcing the machine to drop from about 8 metres height. The lives of the five crew members were saved, but there was considerable damage to the R.I. The cause of the crash was traced back to foreign matter in the fuel tanks, which raised suspicions of sabotage. The date of this incident was August 1915, and the R.I was still under repair on 27 September 1915, but by 13 October 1915 the R.I was at Slonim attached to Feldfliegerabteilung 31.[1] It did not carry out any bombing raids, for continual mishaps and technical problems made the R.I unsuitable for operational service.

In March 1916 the R.I had been dismantled and placed on flatcars for shipment back to Berlin. The fuselage was wrecked in the old Spandau fortress due to lack of clearance caused by a slight shift of the railroad tracks. The fuselage was repaired and the R.I performed useful service as a trainer

[1] For details of the R.I delivery flight to Slonim see Eastern Front Operations chapter.

attached to the Training Section of the Rea at Döberitz from the middle of 1916 until 1918, possibly until the Armistice.

Parts of the indestructible R.I were preserved in a Berlin Museum until World War II, when they were completely destroyed by Allied bombers.

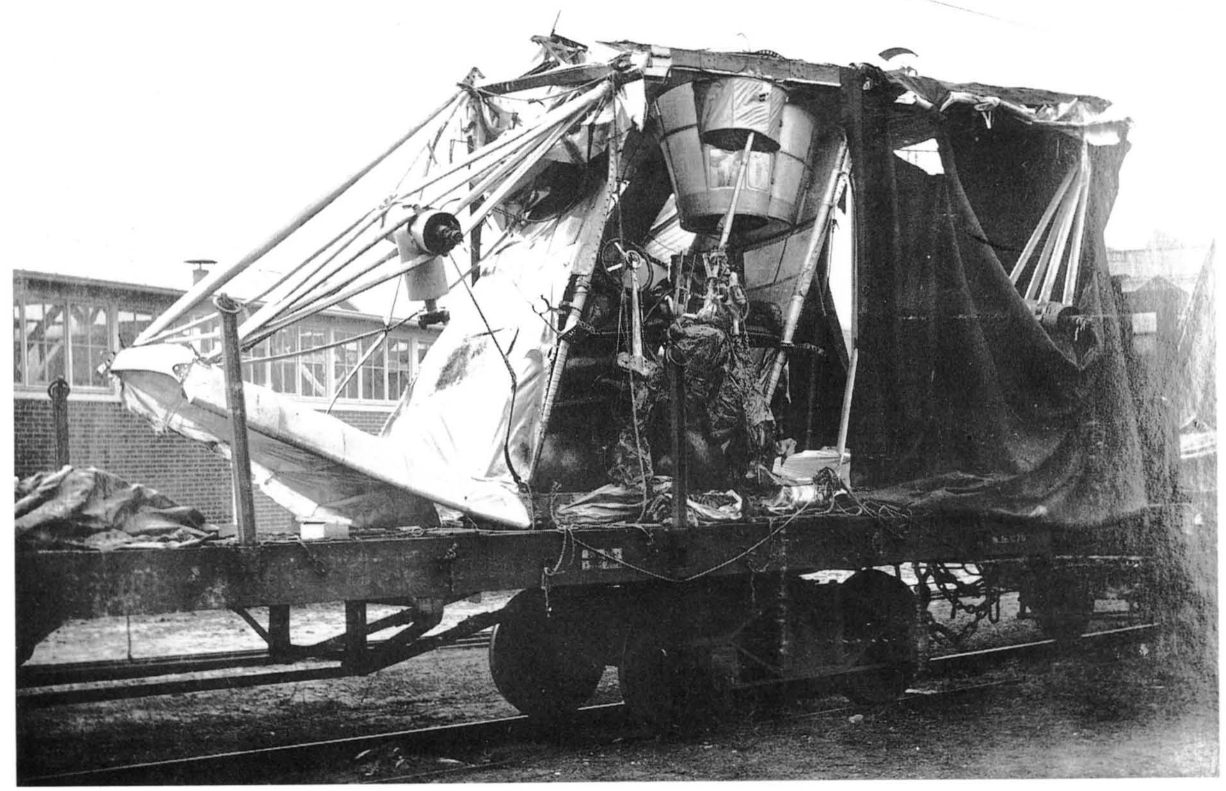
Built with no prior experience in constructing large multi-engined aircraft, the long lived R.I was a tribute to the sound engineering and technical know-how of the Steffen brothers and their associates at SSW. It is a fact that no other centrally-powered R-plane was as successful as the Steffen-designed R-planes, of which the R.I was the prototype, and no other R-plane can lay claim to such a long service record as that enjoyed by the robust R.I.

Colour Scheme and Markings

The R.I had an overall dull buff appearance. Large Patée crosses on white backgrounds were painted on the outer sides of the wings at half-span position. The fuselage markings were painted near the root of the lower boom. No markings were applied to the tail.

SPECIFICATIONS

Type:	SSW R.I
Manufacturer:	Siemens-Schuckert Werke G.m.b.H., Siemensstadt, Berlin
Engines:	Three 150 h.p. Benz Bz.III engines
Propeller Revolutions:	900 r.p.m.
Dimensions:	Span, 28 m. (91 ft. 10 in.)
	Length, 17·5 m. (57 ft. 5 in.)
	Height, 5·2 m. (17 ft. 1 in.)
Areas:	Wings, 138 sq. m. (1485 sq. ft.)
Weights:	Empty, 4000 kg. (8820 lb.)
	Loaded, 5200 kg. (11,466 lb.)



The SSW R.I shown wrecked while on a railway wagon owing to lack of clearance. The upper gun turret can be seen in the wreckage.

Wing Loading:	37·6 kg./sq. m. (7·7 lb./sq. ft.)
Performance:	Maximum speed, 110 km.h. (68·4 m.p.h.) Climb, 2000 m. (6562 ft.) in 35 mins. Ceiling, 3700 m. (12,139 ft.) in 45 mins. Duration, 4 hours Range, 520 km. (323 miles)
Service Use:	Eastern Front 1915–16 and training duties 1916–18
Cost:	100,000 marks

SSW R.II to R.VII

The promise shown by the success of the Steffen-designed SSW R.I bore fruit when Idflieg awarded SSW a provisional contract for six improved bombers on 10 June 1915, barely three weeks after the maiden flight of the R.I. The final contract, signed on 26 June 1915, called for six aircraft powered by 240 h.p. Maybach HS engines to be delivered completely equipped at a cost of 170,000 marks each exclusive of engines. The delivery specifications established by Idflieg for these aircraft read as follows:

Required Performance:

Speed:	135 km.h.
Climb:	2000 metres in 35 mins. 3000 metres in 70 mins. from sea-level
Take-off Run:	150 metres
Landing Run:	200 metres (a landing run of 150 metres preferred)
Useful Load:	about 2450 kg., broken down as—
Fuel:	1000 kg. fuel for 6 hours, but tanks large enough to contain 8 hours fuel
Armament:	300 kg. (one machine cannon at 200 kg. and two machine-guns at 100 kg.)
Crew:	450 kg. (5 persons at 90 kg.)
Bombs:	500 kg.
Armour for pilots:	200 kg.

The new aircraft shall parallel the construction of the demonstrated test machine with the following changes:

The engine-room must have in-flight accessibility (the engine-room under the pilots' seats accessible in a bent-over posture). The remaining areas should have a clear height of 175 cm. (5·7 feet) to permit the engine mechanic to work on all parts of the engines.

In contrast to the arrangement in the prototype, each engine must be capable of being stopped in flight, inspected, re-started and re-coupled into the drive system. Cruising capability shall be maintained on alternate paired engines. The engines shall be equipped with separate controls for the engine mechanic. For the pilots' position central throttle levers for all three engines (as in the prototype) are adequate.

The cooling system shall be common to all engines, with provision for switching and disconnecting its various components. The inlet and outlet water temperatures must be controllable from the pilots' position.

Passage to and from the pilots' cabin, all gun positions and engine-room is mandatory. A telephone loudspeaker or similar device shall be provided to transmit commands to all positions.

Flying characteristics shall be such that the aircraft can be flown by one pilot on long flights without undue fatigue. Horizontal flight on two engines and a 1 to 25 glide ratio on one engine are required.

The acceptance of the aircraft, contrary to normal procedure, shall follow a flight of 6 hours with full load and the acceptance commission aboard. In addition, test flights shall be performed, during the course of which one and two engines shall be stopped.

Ability to take off on two engines with full crew, armament (excluding bombs) and 1 hour of fuel aboard would be desirable.

The company must guarantee gearing and transmission system against design, construction and material failures for 500 hours.

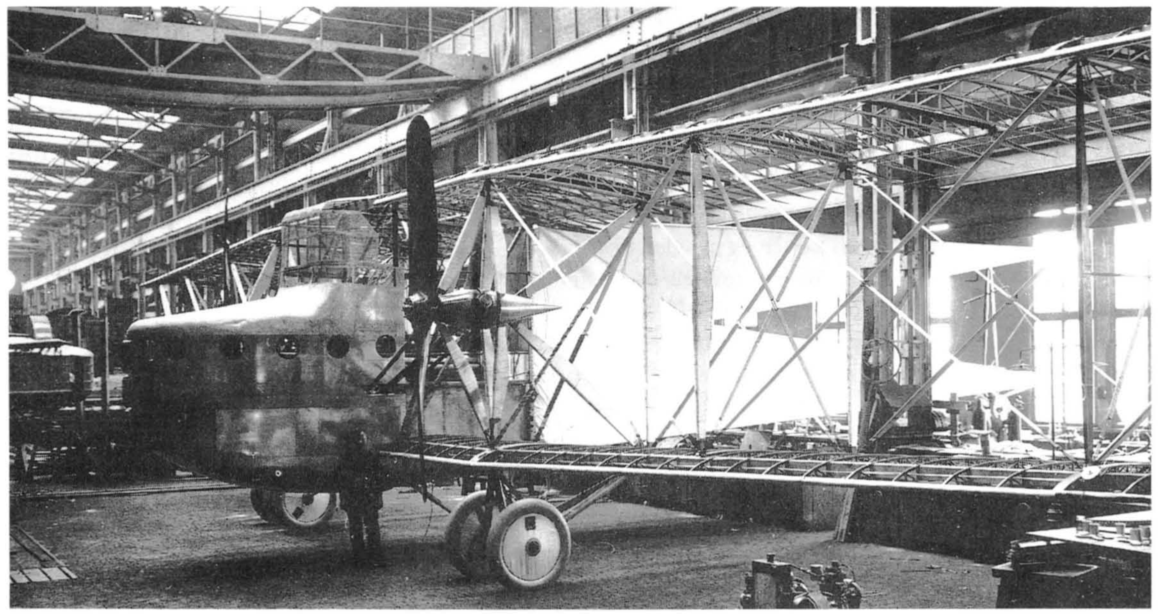
The construction of the aircraft shall adhere to the *Construction and Delivery Specifications for Army Aircraft 1915* (BLV) and its general requirements.

The aircraft will be designated G.32–37/15. The first aircraft will be delivered by the end of September, the second by the end of October and the remainder thereafter in eight-day intervals. In case the Maybach engines are not available, then 220 h.p. Mercedes engines shall be used. The deadline for final delivery of the aircraft, provided the engines are promptly supplied, is 1 April 1916.

These specifications were not unreasonable, and SSW engineers, basing their opinions on the success of the R.I, felt confident that they could build machines to the above requirements within the time limits.

What the engineers could not know, however, was that the designated Maybach HS engine supplied by the Government would be utterly unfit for operational use. Basically a modified airship engine, the HS was prematurely placed into service, and it never did achieve a level of reliability required to power the more demanding heavier-than-air machines. In fact, the engine's operation even in airships proved to be marginal. Its shortcomings plagued SSW for nearly two years and delayed the R-plane's introduction into operational service to such an extent that eventually interest in further development of the Steffen design died out. The Maybach HS was truly the Achilles' heel of the SSW R-plane programme.

In the first aircraft tested (R.2, R.3 and R.4) it was immediately apparent that the HS engine possessed serious mechanical deficiencies not easily remedied. In addition, the engine was highly susceptible to overheating. Virtually every type of radiator configuration was tested at one time or another in the attempt to solve the overheating problem. For example, in the early R.2 three radiators were mounted atop each other in the extreme nose; in the R.4 aerofoil radiators were placed in the



The SSW R.II 2/15 under construction at the SSW Dynamowerk.

upper wing: and later the radiators were mounted on "doors" which could be swung into the slipstream as desired to provide the correct temperature gradients. Much to their consternation, SSW engineers spent much money and valuable time trying to save the ill-fated HS engine. Insisting that it was a firm of aircraft constructors, not engine developers, SSW finally scrapped the Maybach HS engines altogether.

Their place was taken by engines of proven reliability; the 220 h.p. Benz Bz.IV engines (actually rated at 210 h.p.), which powered the R.3 to R.5 aircraft, and the 260 h.p. Mercedes D.IVa engines, which were mounted in the R.2 and R.7.

Because the R-planes were either complete or at an advanced stage of completion, their reconstruction to accommodate Benz and Mercedes engines was costly and, more significant, time-consuming. The first modified aircraft to be completed were those fitted with Benz engines. Subsequent flight tests demonstrated that these machines were underpowered and could not meet Idflieg performance (climb and useful load) specifications. As a consequence, the wing area was enlarged by adding a so-called "supplementary bay" to the wings of the machines, including R.2 and R.7. The latter two aircraft were adequately powered, but the heavier Mercedes engines required strengthened engine bearers, centre-section structure and gear-box. The additional weight (about 400 kg.) required more wing area if the performance specifications were to be met.

Although wingspans of the SSW R-planes were increased from the original three-bay wing to four-, five- and six-bay wings, their general configuration remained constant throughout. The "supplementary bays" were inserted between the centre section (at a point outboard of the propeller housing struts) and the outer wing panels. In size and shape the extra bay or bays were essentially an extension of the centre section. The outer wing panels retained their original appearance, having swept-back leading edges, dihedral on the lower wings and upper wing overhang. The auxiliary balancing surfaces for aileron and elevator assist remained standard.

The airframes of all the Steffen-designed R-planes were characterized by the distinctive forked fuselage. The engines were all serviceable in flight, and although the fuselage was increased in size, the space for the engine mechanic remained cramped. His life was not an easy one. To quote from a contemporary account:

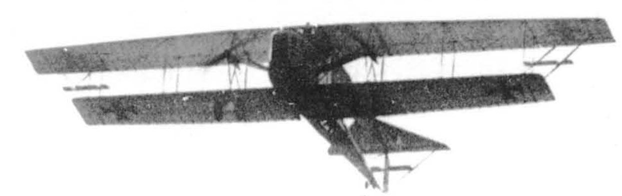
> Because of the construction of the fuselage, it was hardly possible to make repairs on engines or gear-boxes without practically tearing the whole fuselage apart. It took a slim mechanic to fulfil the engine accessibility requirement. Winding his way between engines and fuselage demanded considerable skill in order to avoid an unpleasant contact with the glowing exhaust stacks. The severe space restriction greatly hampered the internal positioning of the exhaust stacks, with the result that a continual battle was fought with bursting exhaust pipes and burned-out gaskets. Duty in the engine-room might be compared to that in a submarine. The mechanic's world consisted of metal walls and oil-smeared portholes which provided his only view of the sky. The heat was often unbearable, and vapours issuing from frequent exhaust leaks added materially to the mechanic's discomfort.

In a report on the R.7, von Bentivegni, the commander of Rfa 501, complained about having to remove the cylinder-head of the left engine in order to renew the exhaust gaskets of the right. The engines were placed that close together!

The gear-box and power-transmission arrangement was an improvement over the prototype R.I, although it operated in the same manner. Von Bentivegni, whose squadron flew the SSW machines, wrote after the war that their greatest fault lay in the engine and drive installation. The three engines and their clutches did not rest on a unified engine mount, but rather on two separate supporting structures. Any shift in the support alignment produced engine misalignment, which in turn caused frequent drive failures. Extensive reinforcement of the drive installation and fuselage, combined with careful inspection after every flight, solved the problem to some extent.

At first the leather-cone friction clutches were operated by long levers extending into the pilots' cabin. It was impossible for the pilots to engage the cone clutch smoothly by means of the long lever. The resulting jerky motion and chatter caused heavy and uneven wear of the leather friction bands.

Later on, the cone clutch was operated by the engine mechanic through a worm-screw hand-wheel, which appreciably prolonged its life. The centrifugal key clutch was burdened by weak key fastenings that often broke. Problems such as this were to be expected in new and unproven drive systems. As time went on, modifications and improvements gradually evolved a reliable internal drive system which von Bentivegni considered fully serviceable and capable of being used in more powerful R-planes. Eventually the gear and clutch system proved to be quite satisfactory, particularly under conditions of careful inspection and servicing, as was the case when the aircraft were assigned to training commands.



The SSW R.II in its original form in flight over Döberitz.

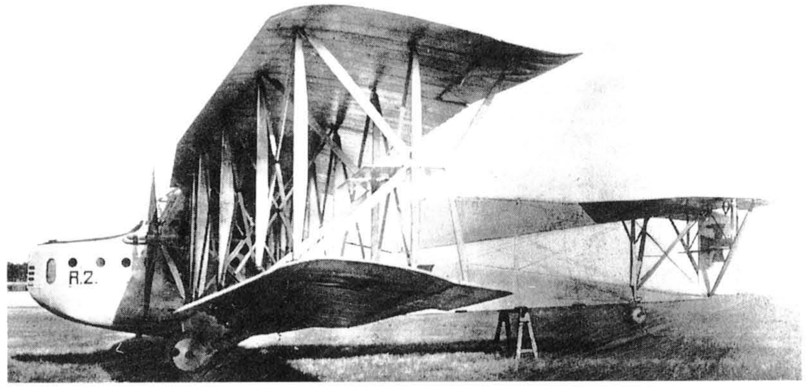
In some eighty flights which he made in SSW R-planes, von Bentivegni experienced only a single propeller transmission failure. He regarded the propeller transmission as an excellent design. The transmission shaft (fitted with sliding and spring-band couplings) and its stiffener tubes were very robust, and the assembly was encased in a small streamlined aerofoil covering.

Von Bentivegni, in defence of the SSW machines, stated that it should not be forgotten that a considerable number of successful day and night missions were flown by these pioneering aircraft. Indeed, their flight characteristics were excellent. They were inherently stable and easy to fly. The concentration of weight provided by the central engine arrangement prevented centre-of-gravity travel when executing turns. To quote a former pilot: "The SSW machines handled like a two-seater."

All machines were equipped with twin doors in the nose to provide entry to the engine-room. The extensive cabin glazing varied in individual machines. It was not popular with the pilots because the Cellon (a type of celluloid) caused dazzle and had a tendency to mist over. Take offs, landings and bad-weather flights were invariably made with open windows to assure clear vision. The drag of the open cockpit must have been appreciable, for a noticeable increase in speed was reported when the windows were closed.

Although the delivery specifications called for one cannon and two machine-guns, full armament was rarely carried. The nose cannon was not fitted, and its heavy ring was replaced by a lighter machine-gun ring. Even so, only one or two machine-guns were carried on bombing missions, as the SSW R-planes generally flew with two-seater fighter escort that provided daytime protection. At night it is likely that no armament or escort was required. The weight saved was made up by loading extra bombs or fuel. The beam machine-gun arrangement consisted of a semicircular mounting that allowed the gun to be swung to either side. A third gun position was located between the upper wing spars above the fuselage. It is believed that all aircraft had a ventral gun position situated behind the rear engine. The 200 kg. armour for the pilots was eliminated to save weight. The undercarriage configuration of the R.I was retained, but was improved upon by having internal spring shock absorbers built into the forward struts.

The usual flight crew consisted of four persons: commander/navigator, two pilots and one engine



The rebuilt SSW R.II 2/15.

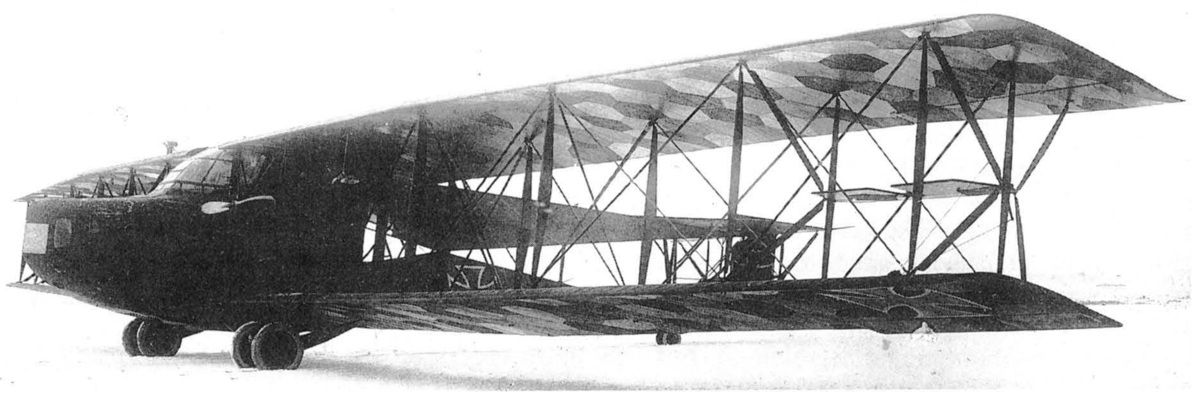
mechanic. With the installation of wireless it is likely that a fifth crew member was carried. There is some indication that only the more powerful long-span machines (R.2, R.7 and possibly R.4) carried wireless equipment. Small propeller-driven generators attached to the upper wing provided power for this equipment, which did not have the range of the Staaken R-plane wireless transmitter. Nevertheless, highly useful and successful triangulation location experiments were performed with SSW R-planes on the Eastern Front. These formed a basis for the wireless navigation technique used by Staaken machines over London and the Western Front.

The original designations of the six SSW machines (G.32 to G.37/15) were changed to G.33 to G.38/15 on 13 July 1915, and as of 6 November 1915 the *Riesenflugzeug* (Giant aircraft) designation was applied for the first time. The SSW machines were allocated numbers R.2 to R.7/15, and each machine received a different type designation (R.II to R.VII) although initially they were intended to be alike.

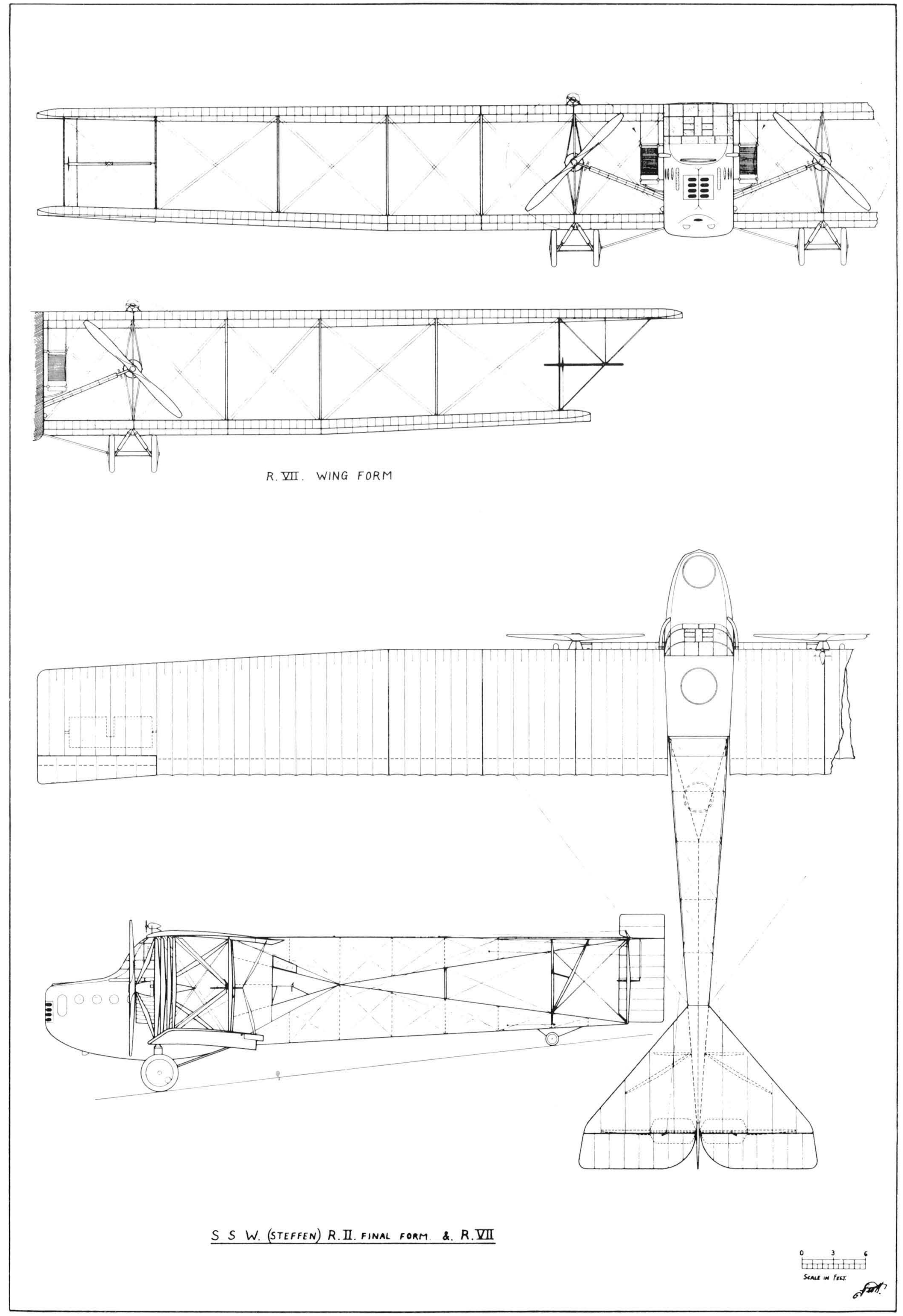
The SSW R-planes were not accepted by Idflieg (Rea) in numerical order. Those aircraft fitted with Benz engines from the outset were delivered and accepted at an earlier date than the Maybach-powered aircraft whose engines had to be torn out and replaced.

SSW R.II 2/15

The R.2, first of the batch of six aircraft to be completed, made its maiden flight on 26 October 1915. This was undoubtedly a creditable achievement on the part of SSW, who took only four months from receipt of contract to build the R.2. Yet curiously enough the R.2 was the last machine to be accepted by the flying services. It was not only a victim of the recalcitrant Maybach engines but also of an extensive modification programme and hesitation by both SSW and Idflieg regarding the choice of replacement engines.



The rebuilt SSW R.II 2/15 with night camouflage applied.



The final crash of the SSW R.2.

The records state that the R.2 was delivered on 20 November 1915, presumably to Döberitz for acceptance tests and inspection under military cognizance. In February 1916, after a series of fruitless flights punctuated by continual failures, the Maybach HS engines were removed and sent back to the manufacturer in Friedrichshafen. Furthermore, the centre section had been damaged when a landing gear collapsed, and the R.2 was returned to the Dynamowerk for repairs. During July 1916 SSW requested instructions from Idflieg on whether to re-install Benz or Mercedes engines. SSW had hoped to have the R.2 ready for flight at the end of the month. Mercedes engines were eventually chosen by Idflieg. By then, however, SSW was hampered by the shortage of skilled personnel, so it was decided to give priority to the completion of the R.5, R.6 and R.7, and the R.2 was placed in storage.

In November 1916 Idflieg requested an increase in operational altitude greater than the 3000 metres initially specified. The minimum altitude was set at 3500 metres, but it was stated that even higher altitudes would be desirable. SSW replied that the installation of Mercedes engines would hardly offer an improvement. Instead, they recommended fitting three Benz engines augmented by two additional Benz pusher engines mounted between the wings to increase the rated power from 630 to 1050 horse-power. SSW argued that this surely would enable the R.2 to reach 3500–4000 metres, and if the modification proved successful the other machines could be altered to the same configuration. Idflieg remained steadfast to the concept of engine accessibility when they wrote, "The R-plane is intended for long-range flights. The principle of engine accessibility during flight shall not be compromised."

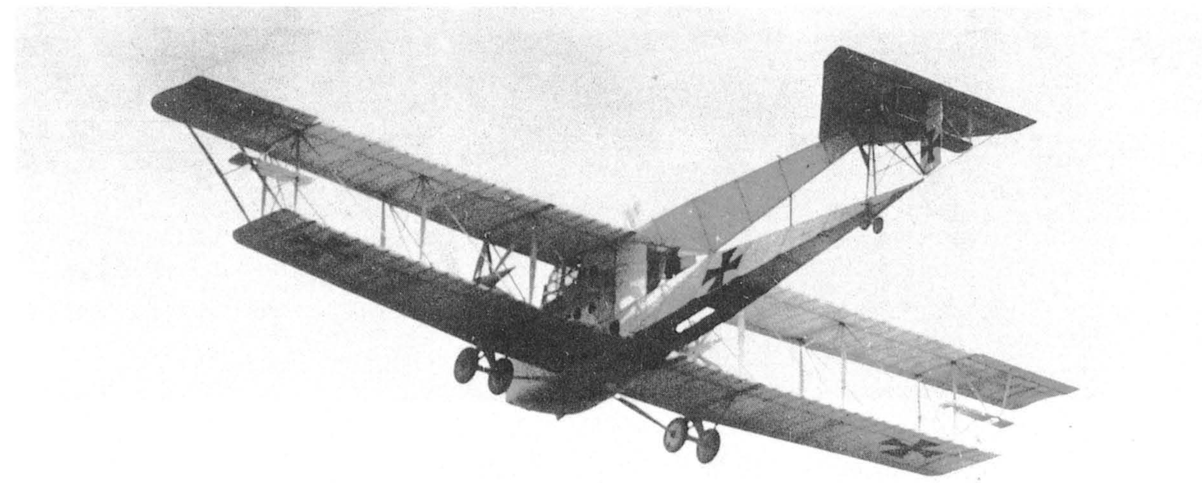
Work on the R.2 was started again in early 1917, by which time it was possible to incorporate lessons learned from the Mercedes-powered R.7. The wings were entirely rebuilt to the six-bay layout by adding a two-bay "supplementary" section between the centre section and the outer wing panels. The spans of the lower and upper wing were equal, but the latter, a completely new structure, had greater chord. Both wings were equipped with ailerons controlled by the distinctive auxiliary SSW balancing surface. The tail surfaces were increased in size and strengthened by additional struts.

In a typical example of front-line and factory co-operation, Idflieg requested on 31 March 1917 that the R.2 be equipped with under-wing bomb racks for both 50 kg. and 100 kg. bombs. Operational flights had shown the R.7 to be capable of carrying six 50 kg. bombs in addition to its internal bomb load, and the R.2 was to be modified to carry either six 50 kg. or four 100 kg. bombs.

On 29 June 1917 the R.2 was delivered to Rea after performing an acceptance flight of 4 hours, during which it reached 3800 metres in 86 minutes carrying a 2310 kg. useful load. The flight was a noteworthy improvement over the other SSW machines, which could only attain 3000 metres with a 1400–1700 kg. useful load. However, the increased span and weight of the R.2 restricted its maximum speed and prevented it from competing with Staaken R-plane types then entering operational service. It was relegated to training duties at the R-plane school in Döberitz, and in June 1918 it was transferred to Rea Cologne, where it is known to have crashed later that year.

SSW R.III 3/15

The R.3 was completed about one month after the R.2, and following several test flights by Bruno Steffen was delivered to Döberitz on 30 December 1915. During subsequent flights extensive engine and radiator modifications were made, but these stop-gap measures could not cure the recurrent defects of the HS engines. The R.3 crashed in early 1916, and it is believed the HS engines were responsible. The damaged wings were replaced, but attempts at further flights with the HS engine were futile, and the R.3 was returned to the Dynamowerk to have its engines replaced. On 2 June 1916 SSW wrote Idflieg requesting permission to install Benz engines, but Idflieg answered that the R.3 was to remain in storage until SSW had available man-power and space. On 12 October 1916 a number of modifications, found useful in front-line service with the R.5 and R.6, were to be incorporated in the R.3. These included reinforcement of the tail to prevent in-flight vibrations; engine and gear-box thermometers for the mechanic; engine-room illumination so that the mechanic could service the engines during night flights, and provision for covering the radiators in flight. At the time the enlarged wingspan of the R.4, R.5 and R.6 had proved its value, and a similar section was added to the wing with increased chord. The Benz-powered R.3 was finally delivered to relaxed specifications (see SSW R.6), although Idflieg acknowledged that the machine was not capable of front-line service. The R.3 was delivered to Rea on 12 December 1916 and was accepted on the 21 December 1916. The machine performed a useful function as a trainer, and it was still in service on 23 February 1918.



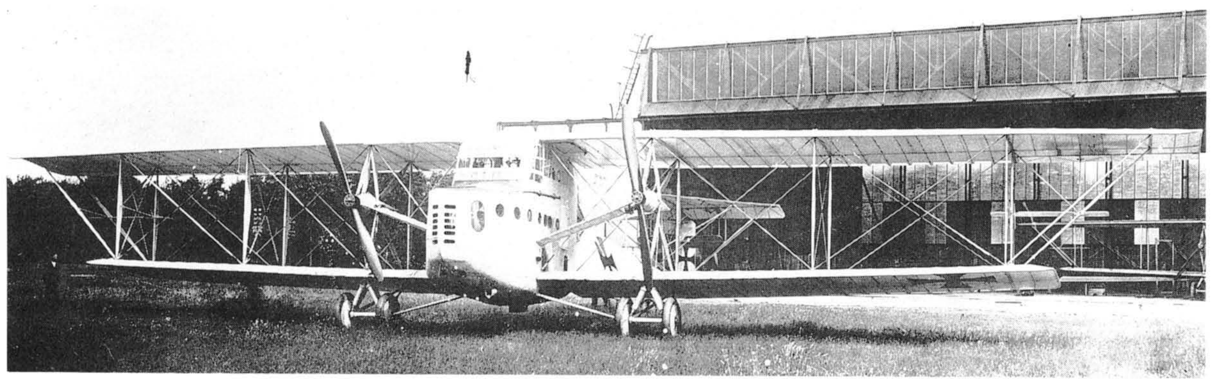
SSW R.III 3/15.

SSW R.IV 4/15

The R.4 was perhaps the only aeroplane with Maybach HS engines ever to be accepted by the German Government. This feat was possible because the R.4 was singled out for extensive engine and radiator modifications in a special effort to prove the HS airworthy.

Factory delivery of the R.4 took place on 29 January 1916. Hardly had the test flights begun when it was necessary to exchange the original HS engines for new ones. Simultaneously the nose radiators were replaced by wing radiators and gravity fuel tanks were installed. According to SSW records, the HS-powered R.4 did not perform a useful flight until May 1916, but even then one of the cylinders turned blue from overheating. Nevertheless, SSW was hopeful that still larger radiators would solve the HS overheating problem, and suggested to Idflieg that further experiments with the HS engines should be made. On the other hand, SSW did not feel responsible for the defective engines, nor did it have the necessary personnel to perform engine-modification work. Consequently SSW asked Idflieg to accept the machine and continue the test programme on its own. Idflieg consented to an acceptance flight during which the R.4 was to climb to 3000 metres in 90 minutes with a useful load of 1810 kg. (For a breakdown of the useful load see R.7.) This requirement was passed by the R.4 on 27 August 1916, some six months after it was rolled out of the factory, and the machine was accepted by Rea on the same day. Some time during this period the wing bays of the R.4 had been increased to four by the addition of the usual supplementary bay.

In November 1916 the R.4 was under repair, probably as a result of a crash. The opportunity was



SSW R.IV 4/15.

taken to replace the HS engines with three Benz Bz.IV engines. Either concurrently or at a later date the wingspan was increased a second time and the final configuration resembled the five-bay wing of the R.7. The repair work was completed on 14 February 1917, and the first flight with Benz engines was made on 14 March 1917.

On 27 April 1917 the R.4 joined Rfa 501 at Vilna, where it performed several operational missions. It crashed in April 1917, but was repaired. When Rfa 501 was transferred to the Western Front the R.4 was left behind as a trainer with the R-Training Section in Vilna, where it is known to have been in early 1918, but was later flown back to Berlin. On 22 June the R.4 made a safe emergency landing between Spandau and Staaken; the damage was repaired two months later on 28 August 1918.

In 1917 the R.4 had been considered as a carrier for the SSW-developed wire-guided air-to-ground missiles. Although a special monoplane missile for large aircraft had been designed, the ground clearance of the R.4 was insufficient to allow its use as a carrier without extensive modification, and the idea was dropped.

SSW R.V 5/15

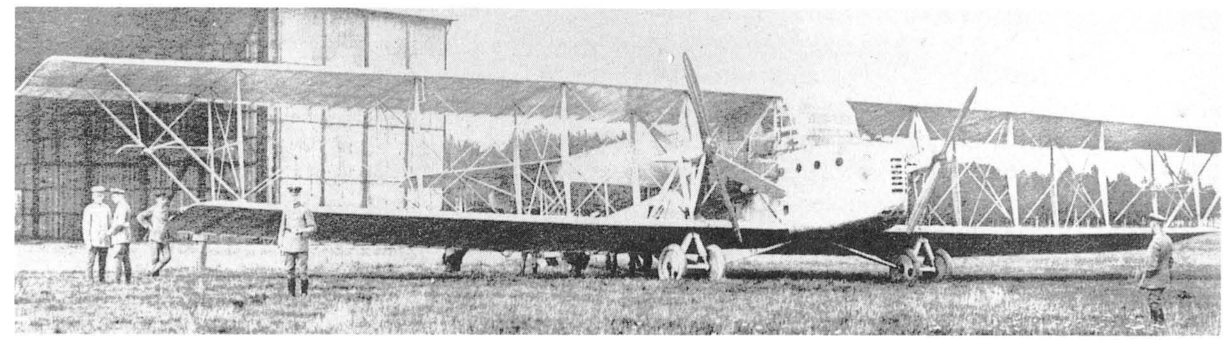
Though never actually powered by the HS engine, the history of the R.5 did not escape its influence. The R.5, virtually finished when the change to Benz engines was decided, had to be completely

rebuilt, including the customary increase in wingspan. The R.5 left the factory in June 1916. Idflieg agreed to accept the R.5 to lower specifications than stipulated in the contract (see SSW R.6 for details).

The R.5 was delivered to Rea on 13 August 1916 and then flown to Rfa 501 to join the recently-arrived R.6. The account of the delivery flight has been preserved, and it makes an interesting catalogue of the R.5's virtues and defects. On 3 September 1916 the aircraft took off from Döberitz for a non-stop flight of 620 km. to Königsberg via Schneidemühl. The total load of 1836 kg. included the commander, Lt. Rau, a crew of five and ten auxiliary fuel tanks hung in the bomb racks, which, in addition to the main tanks, provided enough fuel for 6½ hours duration. The flight was made at about 2000–2300 metres in varying overcast weather, but sight of the ground was fortunately never completely lost.

Just short of Schneidemühl, the halfway mark, Lt. Rau noticed that the thrust ball bearing of the left leather-cone friction clutch was running hot. The clutch was immediately disengaged, but not in time to prevent disintegration of the bearing cage in a shower of red-hot parts and sparks. However, the centrifugal key clutch was still intact, and as it was not necessary to have the cone clutch engaged simultaneously, Lt. Rau chose to fly on.

The flight report digresses to advocate the placing of the clutch levers in the mechanic's position. The reason given was that only the mechanic could determine the degree of "clutching" necessary to friction-start a decoupled engine in flight, while simultaneously adjusting the ignition and other



SSW R.V 5/15 on the Rfa 501 airfield at Alt-Auz.

engine controls. Using a proposed worm-screw hand-wheel (instead of the long extension lever for the pilots), the mechanic could carefully adjust the cone friction clutch to the required degree, thereby reducing wear and tear on the clutch.

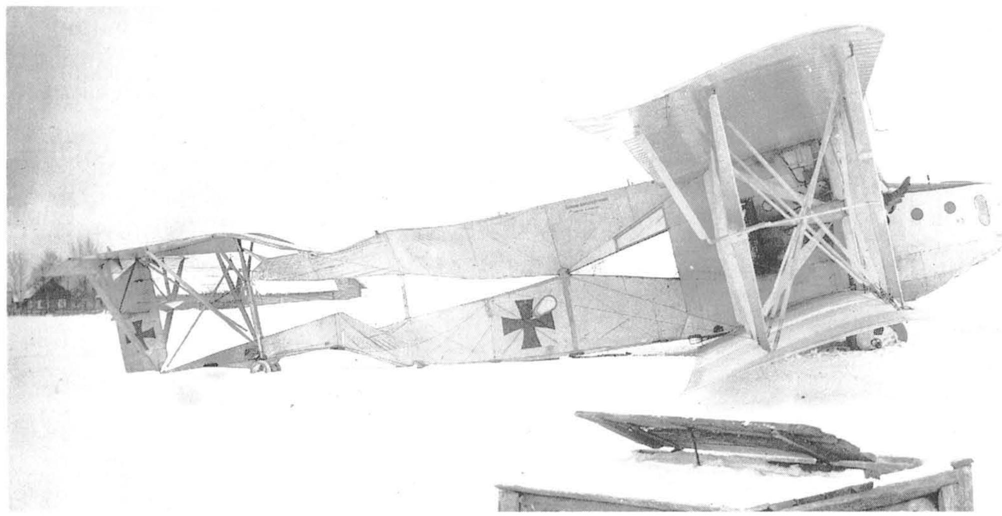
During regular flight the cone friction clutch would be disengaged, but during a landing or gliding manoeuvre (when the engines are throttled down) the cone friction clutch would be engaged in case the centrifugal key clutch should decouple. The potential danger in having the pilots operate the clutch was clearly demonstrated during the landing at Königsberg. The engines were throttled down and the centrifugal key clutches automatically disengaged. However, the left engine, with its broken and previously disengaged cone friction clutch, robbed of its flywheel action, promptly stalled. Although the cone friction clutch was still serviceable, the pilots were too busy fighting the strong ground air currents to concern themselves with the clutch. It is possible they had not even noticed the engine stall in the tension and noise. The mechanic had, but he was powerless to take remedial action, as the clutch lever was located in the cockpit.

It is a tribute to the flying qualities of the Steffen-designed R-planes that the R.5 handled excellently in the strong turbulence even though one engine had stopped. The aircraft landed at Königsberg after a flight of 4 hours and 50 minutes.

On the next day the R.5 flew to Vilna via Kowno, a distance of about 340 km. The trip required less fuel, and one extra passenger was taken along. The R.5 climbed to 1500 metres in 18 minutes with a load of 1755 kg., a creditable performance. The broken cone clutch was used only for the

take-off, and it was disengaged as soon as the R.5 was in the air. The machine landed in Vilna in 2 hours and 38 minutes and made the trip at an average speed of 128 km.h. The repairs on the clutch were begun at once, and the defect was traced back to a loose bolt in the coupling of the right engine which had wandered through the gear-box to cause the bearing failure in the left engine. The complete gear-box had to be disassembled to replace the bearing, and this required its removal from the aircraft. To do so, either the two front engines and the nose cowl or the rear engine and one fuel tank had to be removed.

The R.5 flew a number of bombing missions with Rfa 501 during the turn of the year 1916. The Operational History (page 22) mentions some of the problems encountered by the R.5 and includes one report of a raid on Iza by the R.5.



After the above incident in February 1917, the damaged SSW R.5 was dismantled to provide spares for the remaining SSW R-planes.

During the week of 14 February 1917 the R.5 was severely damaged in a faulty night landing and was dismantled for shipment back to Döberitz, where its parts were stored as spares for Rea.

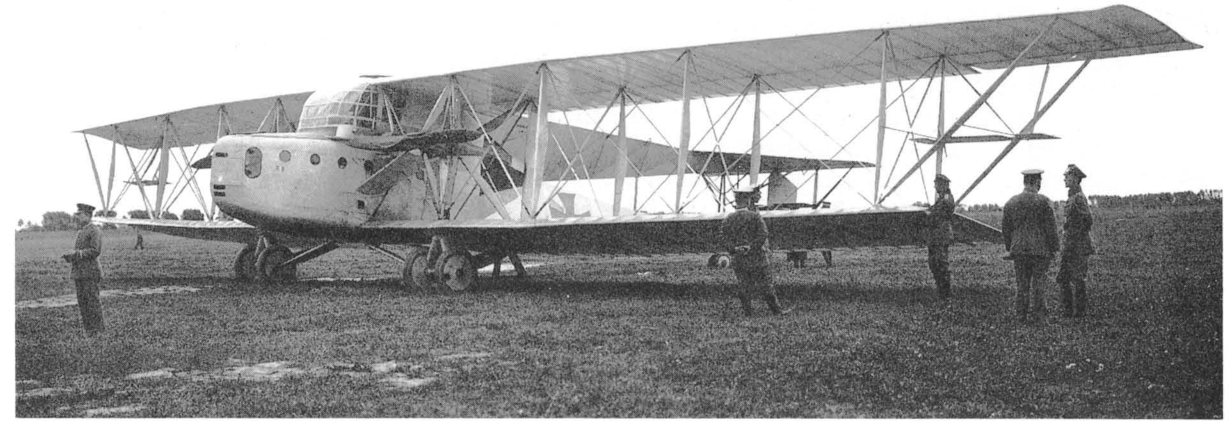
SSW R.VI 6/15

Unlucky throughout its career, the R.6 was still one of the most successful SSW R-planes. Not only was it the first aircraft of the R.2–7 series to reach squadron service but during its flight tests it achieved an unacknowledged world record.

Like the R.5, the R.6 was partially complete when the change to Benz engines required fuselage modification and an increase in wingspan. There is some evidence that the wing was not enlarged until after the record-breaking flight described below. The R.6 left the Dynamowerk on 25 April 1916 and performed a number of successful test flights under Bruno and Franz Steffen. After fitting wing radiators, the R.6 performed a 6-hour factory flight (possibly with military observers on board). SSW was hopeful that Idflieg would accept the R.6 on the strength of this flight.

The flight was a remarkable one, for the R.6 piloted by Bruno Steffen carried a pure useful load of 2400 kg. for a duration of 6 hours. The flight constituted a world record at the time, but the war prevented any publicity of the event or promulgation of the record.

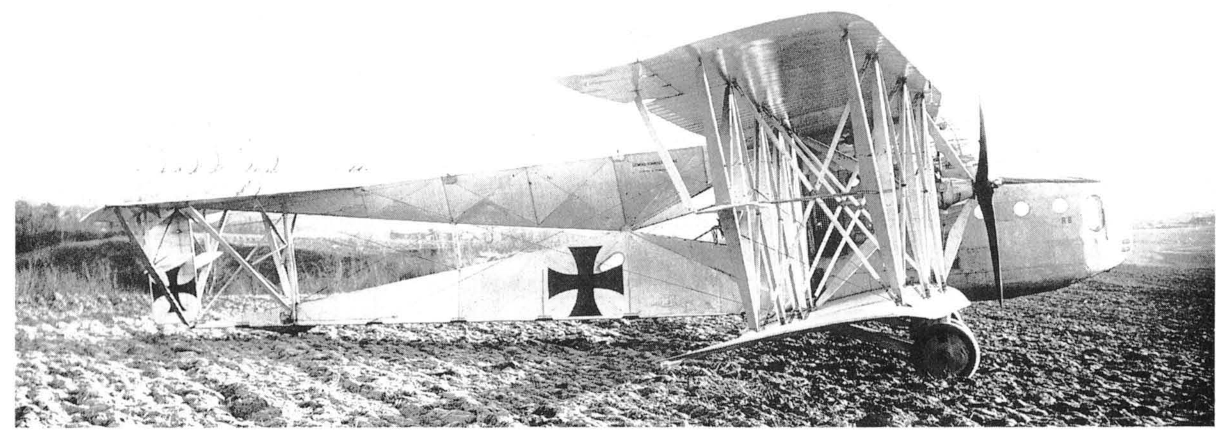
A former member of the SSW engineering staff, Hans Heitmann vividly recalls his participation in a 6-hour flight, although he is not sure of the aircraft's designation. At any rate, such flights were not without their exciting moments, as the following account will testify. One has to admire the almost nonchalant attitude of the crew, to whom a minor failure or accident was routine. In today's high-



SSW R.VI 6/15 at Kowno in August 1916.

bred aircraft similar happenings would be due cause for an immediate emergency landing. The flight described below could well have been the memorable 6-hour record of the R.6.

> Because of the heavy load and the lack of wind, the take-off run was prolonged. During the take-off I was stationed near the rear engine. While we were still gathering speed the hose leading to the radiator burst, dousing my legs with water. I stopped the leak with a handy oil rag and quickly wrapped wire around this compress, reinforced it with friction tape and secured it with another layer of wire. This make-shift patch lasted the entire flight, and we had only lost 2 litres of water. By then we were airborne and no one aboard had noticed anything amiss. You may imagine the disgrace if we had been forced to cancel the flight after barely reaching 100 metres altitude.
>
> But even better things were to come. From the beginning to end we were able to stay aloft only because of timely emergency repairs. I do not remember the exact sequence of incidents, but perhaps the enclosed messages which we passed back and forth will provide a clue. The engine noise made it impossible to talk and be understood; consequently every



Emergency landing by the SSW R.VI 6/15 in a ploughed field near Vilna, December 1916.

15 minutes we handed a message to the pilots with information regarding engine revolutions, engine, gear-box oil and water temperatures.

The exhaust pipes of the front engines were separated by no more than the thickness of a sheet of paper for about 1 metre. Here too, a pipe split open, spewing poisonous exhaust fumes into the engine-room. A special ring fashioned from wire was wrapped around the red-hot pipe and twisted tight with a short stick, thereby squeezing the opening shut. This repair lasted for the remainder of the flight, although it did re-open a millimetre or two.

Shortly thereafter we became aware that the left engine was using oil faster than the other two engines. Inspection showed that an oil pipe near the base of the crankshaft housing had fractured. The leak was stopped with a wooden plug. But how long had the engine run without oil? We drew off oil from the other engines and filled the left engine, a task that kept one of us busy for the rest of the flight.

The flight was almost over and the pilot had idled the engines to descend for the landing. Suddenly he notified us that the left engine was dead. We had not noticed it. Undoubtedly the engine had run too long without oil and the pistons had seized. The idled left engine, not able to overcome the friction of the pistons, had reduced its speed to a point where the centrifugal clutch had automatically disengaged and the engine had stopped. Spark plugs were taken out, oil was poured into the cylinders and slowly we began to turn the engine using the friction clutch. After a moment we replaced the plugs and "clutch-turned" the engine as the pilot gave gas. The engine started, came to 1550 r.p.m. and did not complain again until we shut it off in the hangar. We had endured the 6-hour flight! Never again during acceptance and even factory flights did an SSW machine experience so many mishaps.

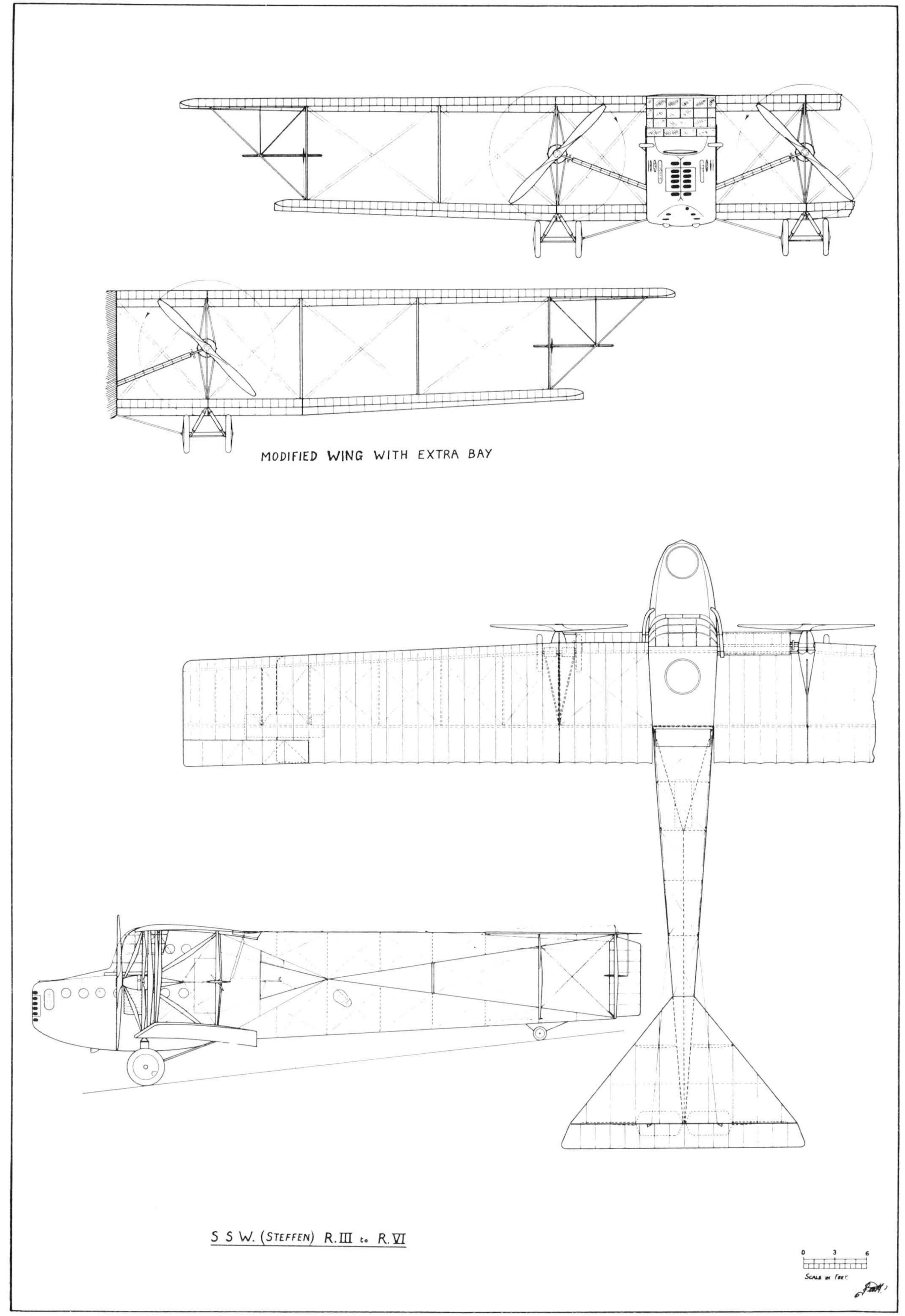
Notwithstanding the load-carrying and duration record, the rate of climb and ceiling of the R.6 was still marginal. Two climb tests performed under Idflieg surveillance (8 and 14 June 1916) gave such poor results that Idflieg relaxed the delivery specifications. The useful load was reduced from 2450 kg. to 1410 kg. now made up of:

Fuel	490 kg.
Gear-box oil	110 kg.
Engine oil	40 kg.
3 machine-guns	150 kg.
Crew (four)	320 kg.
Bombs	250 kg.
Miscellaneous	50 kg.
Total	1410 kg.

The specified climb with this load was 3000 metres in 90 minutes. The fuel tanks were to carry a reduced quantity for 4 hours duration. The heavy cannon ring was discarded, the starter motor and battery were to be either eliminated or included in the useful load calculations.

The R.6 (and later the R.5 and R.3) passed these reduced climb and load requirements and was delivered to Rea on 20 July 1916. On 7 August the R.6 was delivered to Rfa 501 after having landed at Kowno to repair a failing engine. Its first bombing mission, made in the daytime, was against the Russian railroad station at Molodeczne. During October 1916 the R.6 and R.5 were fitted with two bomb containers inside the rear fuselage, each holding five 12·5 kg. P.u.W. bombs. This installation made the aircraft tail-heavy and changed its trim after the bombs were released. It was replaced by external racks (for eleven 12·5 kg. bombs) placed underneath the fuselage closer to the centre of gravity.

The R.6 was dogged by misfortune during its operational career. On 26 November 1916 it took off in company with the R.5 to bomb Iza, but was forced to land due to a leaking compression cock (see Operational History page 24). The R.6 survived an in-flight fire caused by a burned-through engine and made an emergency landing on 11 December 1916. The substitute engine did not arrive at Vilna until 9 January 1917. At the time it was more desirable to place this engine into the R.5, which also



was grounded. But the engine, fitted with a flange for the R.6 gear-box, was not interchangeable with the R.5, and the squadron report ended with a plea for standardization of parts.

Records list the R.6 as damaged in March and again in the summer of 1917. In November 1917 the R.6 was considered to be of no further use and was dismantled.

SSW R.VII 7/15

The R.7, initially to be powered by Maybach engines, was the first SSW R-plane to receive Mercedes engines. Existing documents concerning the history of the R.7 are not entirely consistent, and there is a possibility that Benz engines were considered prior to installation of the Mercedes engines. A SSW factory report dated 2 June 1916 stated that the R.7 equipped with Benz engines would be ready to leave the Dynamowerk on 24 June 1916. However, an Idflieg document dated 17 June 1916 asks SSW to expedite the installation of the 260 h.p Mercedes engines in the R.7. It is assumed that a decision was made in the interim period to equip the R.7 with the more powerful Mercedes engines.

This change required extensive reconstruction to strengthen the airframe and drive assembly to accept the heavier and longer Mercedes D.IVa engines In the process, fuel tanks, propellers, landing gear and the forward fuselage section had to be modified or rebuilt. Completely new wings were fabricated, featuring heavier spars and a new rib section.

The span was increased to a five-bay configuration by the addition of two "supplementary" bays. The tailplane area was increased and the elevator was divided to allow clearance for an enlarged rudder. Large slab radiators were mounted on each side of the fuselage between the wings.

On 11 November 1916 Idflieg pressed SSW to accelerate the completion of the R.7, for in the interest of R-plane development it was a matter of urgency to have a Mercedes-powered machine completed as soon as possible. The main section of the R.7 left the factory on 20 November 1916 and was shipped to Döberitz for assembly. To explain the delay, SSW countered by stating that the change to Mercedes engines had required new wing spars and wings, new strengthened engine bearers and an enlarged fuselage with a modified interior layout. During the R.7 modification programme, SSW stated, the R.3, R.4, R.5 and R.6 had been completed and the R.I repaired. Yet only four months had passed from the time the engines were delivered, in spite of a greatly reduced number of available skilled workers.

The R.7 was test-flown on 15 January 1917 and made two acceptance flights; one on 21 January, during which it reached 300 metres in 66 minutes (useful load unknown) and a second flight on 1 February (useful load unknown) during which it reached 2500 metres in 2 hours and 51 minutes. The reduced useful load specified by Idflieg for the R.7 (R.2 and Maybach-powered R.4) was as follows:

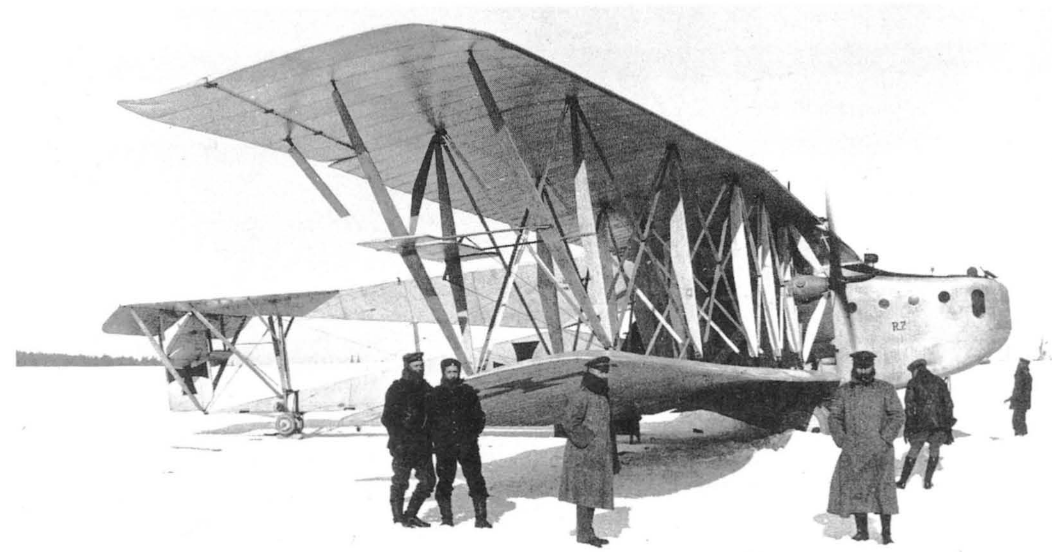
Fuel	640 kg.
Gear-box oil	110 kg.
Engine oil	40 kg.
3 machine-guns	150 kg.
Crew (four)	320 kg.
Bombs	500 kg.
Miscellaneous	50 kg.
Total	1810 kg.

The original wings were found to be too heavy, and some time during the tests the R.7 was fitted with completely new wings of lighter construction.

Rea took delivery of the R.7 on 11 February 1917, and within two weeks, on 26 February, it was flown to Rfa 501 in Vilna. There the aircraft was thoroughly inspected and the exhaust manifolds were found to be in poor shape, necessitating immediate replacement of the right and rear manifolds and temporary patching of the left. Other field modifications included fitting an easy to open and close windows in the Cellon canopy; painting the underside of the wings grey for night protection; relocating the Anschütz artificial horizons inside the Cellon canopy because it was difficult to read through the thick Cellon windows; installing reading lights for all the controls; installing an Atmos and a balloon variometer in the cabin and an airship compass in the commander's position.

The greater power of the R.7 made it possible to carry a bigger bomb load. In addition to the factory-installed internal racks for six 50 kg. Karbonit bombs, racks for twelve 12·5 kg. P.u.W. bombs were added beneath the fuselage behind the landing-gear struts. Additional racks for three 50 kg. P.u.W. bombs were also fitted under each wing between the fuselage and the propeller struts. With all racks filled the bomb load came to 750 kg.

Modifications were finished by 8 March 1917, and the R.7 was reported now ready for flight. Two days later a take-off attempt failed when newly-fallen, heavy snow prevented the R.7 from gathering sufficient speed. On 12 March 1917 the R.7 made its first flight from the Rfa 501 airfield.



SSW R.VII 7/15 on the Rfa 501 airfield at Alt-Auz.

The flight attitude, particularly while gliding or in gusty air, was not as satisfactory as that of the other SSW R-planes assigned to Rfa 501. It was felt that the large span and increased chord in relationship to the short fuselage had a detrimental influence on the R.7's flight characteristics. None of the instruments operated properly during the flight, but this was to be expected from untested and uncalibrated equipment.

A wireless sender and receiver was installed in the R.7. Three ground stations picked up signals transmitted by the R.7 while it was in the air. It had been arranged beforehand that these stations would attempt to determine the aircraft's bearing, which they did correctly. Here was the beginning of the triangulation technique used later by Staaken R-planes to fix their positions over enemy territory. No return signals were received by the R.7 because of vibrations in the improperly suspended receiver. In the urgency to deliver the R.7 to the front it had been equipped with unsuitable propellers. Consequently the flight was terminated in 46 minutes because a more exact determination of the machine's capabilities was not feasible.

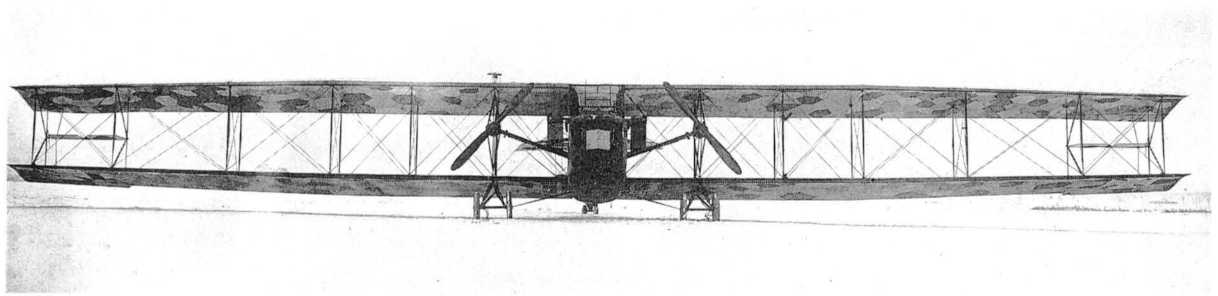
The R.7 started on its first operational mission on 15 March 1917. Just short of leaving the ground a sharp crack was heard, followed by severe shaking of the entire engine assembly. It was found that the spur gear of the left engine had disintegrated, which was traced back to a failure of two key plates in the centrifugal clutch. The critical structure, assembled from two pieces, was replaced by a part fabricated from a single metal block. This field modification proved to be very satisfactory and found use in other SSW R-planes.

The R.7 participated in bombing missions until the summer of 1917, when Rfa 501 was transferred

to the Western Front. From then on the R.7 was attached to the R-Training Section in Vilna, and is known to have been there in January 1918.

The year 1917 saw the end of the developmental cycle of the Steffen-designed R-planes. In retrospect they were rather remarkable aircraft. Designed in 1914/15, the intrinsic qualities of manoeuvrability, ruggedness and reliability permitted the SSW R-planes to serve as trainers until the end of the war. It is a tribute to the safety of these aircraft that not one life was lost in them. Unquestionably, the SSW R-planes were the most successful of the internally-powered R-planes produced by Germany during the war, even though they were underpowered.

Von Bentivegni felt that the experiences of the first years should have been applied to the development of improved types. It certainly would have been possible. For example, the R.2, a type designed



SSW R.II 2/15.

in 1914/15, after numerous modifications and improvements climbed to almost 4000 metres with a full war load.

Why, then, were the Steffen-designed SSW R-planes not developed further? It is difficult to pinpoint any major reason, but rather a number of factors were responsible for the lack of interest in furthering the Steffen design. In the first place, the early death of one of the designers during the critical year of 1916 robbed the project of much impetus. Franz Steffen crashed to his death on 26 June 1916 in the SSW E.II, an aircraft he had designed. Secondly, SSW had suffered heavy financial losses in frustrated attempts to make the R-planes fly with the deficient Maybach HS engine; not to mention the costly and time-consuming modifications required to change over to different engines. Disillusioned and seeing that time was running out, SSW and Steffen turned to a much more profitable, if not more exciting, area of work. In late 1916 they began to construct in large quantities the beginning of a line of high-performance single-seat fighters. These endeavours continued at an ever-increasing pace until the war's end. The demand for fighters was enormous, and virtually all of the SSW resources were placed behind the fighter programme to the detriment of the R-plane.

Colour Scheme and Markings

All six SSW R-planes left the factory in a natural clear dope finish. Serial numbers (R.2, R.3, etc.) were painted in small black figures on both sides of the forward fuselage. The aluminium panels on top of the forward fuselage section were painted black as an anti-dazzle aid. The cross Patée without the usual borders or backgrounds was painted on the wingtips, on the lower boom of the fuselage and on the rudders. As the aircraft reached operational status they may have been repainted. The R.2 in the final form was painted in a dark colour; its wings were covered with a pattern of large regular hexagons, and the Latin cross was painted on the wings and lower boom. The underside of the R.7 wings were painted a grey colour after it attained operational status.

SPECIFICATIONS

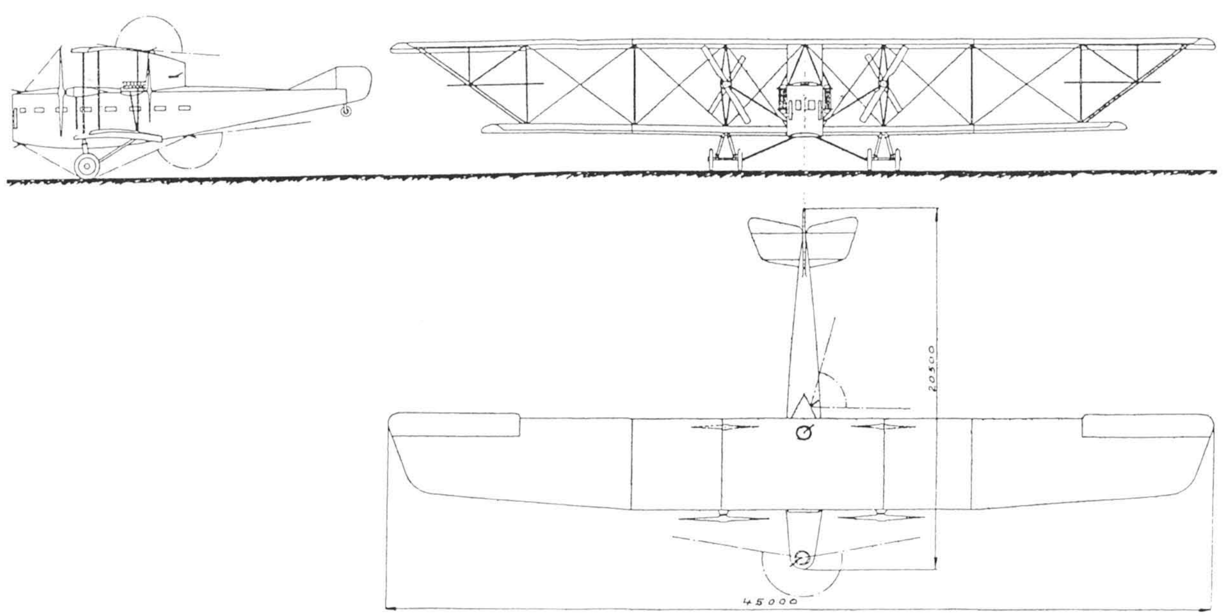
Type: SSW R.II to R.VII
Manufacturer: Siemens-Schuckert Werke G.m.b.H., Siemensstadt, Berlin

Type		R.II 2/15		R.III 3/15		R.IV 4/15		R.V 5/15	R.VI 6/15	R.VII 7/15
Engines	Units	3 × 240 h.p. Maybach HS	3 × 260 h.p. Mercedes D.IVa	3 × 240 h.p. Maybach HS	3 × 220 h.p. Benz Bz.IV	3 × 240 h.p. Maybach HS	3 × 220 h.p. Benz Bz.IV	3 × 220 h.p. Benz Bz.IV	3 × 220 h.p. Benz. Bz.IV	3 × 260 h.p. Mercedes D.IVa
Span	m. ft. in.	28·22 92 7	38·0 124 8	28·22 92 7	34·33 112 7	28·22 92 7	37·6 123 4	34·33 112 7	33·36 109 5½	38·44 126 1½
Length	m. ft. in.	17·7 58 1	18·5 60 8½	17·7 58 1	17·7 58 1	17·7 58 1	18·0 59 ½	17·7 58 1	17·7 58 1	18·5 60 8½
Height	m. ft. in.	4·6 15 1	4·6 15 1	4·6 15 1	4·6 15 1	4·6 15 1	4·6 15 1	4·6 15 1	4·6 15 1	4·6 15 1
Area	sq. m. sq. ft.	156 1,679	233 2,507	156 1,679	177 1,905	156 1,679	201 2,163	177 1,905	171 1,840	210 2,260
Weight empty	kg. lb.	5,350 11,797	6,150 13,561		5,400 11,907		5,450 12,017	5,300 11,686	5,250 11,576	5,700 12,568
Weight loaded	kg. lb.	7,150 15,767	8,460 18,654		6,820 15,038		6,900 15,214	6,766 14,919	6,800 14,994	7,960 17,552
Wing loading	kg./sq. m. lb./sq. ft.		36·5 7·5		41·7 8·5		36·2 7·4	41·7 8·5	41·7 8·5	33·3 6·8
Maximum speed	km.h. m.p.h.	130 80·8	110 68·4		132 82		130 80·8	132 82	132 82	130 80·8
Climb	m./min.		2000/23 3000/45		2000/35		2000/36 3000/104	2000/36 3000/102	2000/36	2000/27 3000/66
Ceiling	m. ft.		3,800 12,468		3,000 9,843		3,050 10,007	3,000 9,843	2,950 9,679	3,200 10,499
Duration	hrs.	5¼	4		4		4	4	4–6	4

SSW R.VIII

The SSW R.VIII was the largest aircraft in the world at the time of its completion, a mammoth aircraft even when judged by today's standards. Its record 158 foot wingspan was not surpassed for nearly a decade following World War I. The R.VIII was Siemens-Schuckert's final contribution to the German R-plane effort. The design projects from which the R.VIII eventually evolved were first mentioned in November 1916, when Idflieg wrote, "In spite of constant pressure, the work on the 1000 h.p. project does not seem to have progressed very far." Indeed, SSW wanted to gather more experience with the R.7 before proceeding on the project, much to Idflieg's consternation. A second project was also mentioned. "SSW feels that discussion of a 2000 h.p. aircraft is completely out of the question at the moment. Their attitude stands out in contrast to the other R-plane manufacturers, who are diligently pursuing the problem." However, in light of their discouraging experiences and financial losses with the R.2/7 series and their growing fighter aircraft activity, it was understandable that SSW would view further R-plane construction with half-hearted interest. But two factors were responsible for the reawakening of the firm's enthusiasm in the middle of 1917. Idflieg, ever anxious to strengthen its R-plane squadrons, continued to apply pressure for a new giant bomber design. Secondly, the last aircraft of the R.2/7 series was nearing completion (the R.2), and SSW was reluctant to let its investment in experience and facilities go to waste. In the summer of 1917 a contract was signed for the construction of two R-planes at a cost of 750,000 marks each. Based on the ideas of Dr. Reichel, these aircraft were designed by Dipl.-Ing. Harald Wolff, head of the SSW design bureau, and bore the designation SSW R.VIII 23/16 and 24/16. Records do not exist to explain why these aircraft received a 1916 order number, but it is possible that they were ordered under funds made available for the large R-plane allocation of 1916.

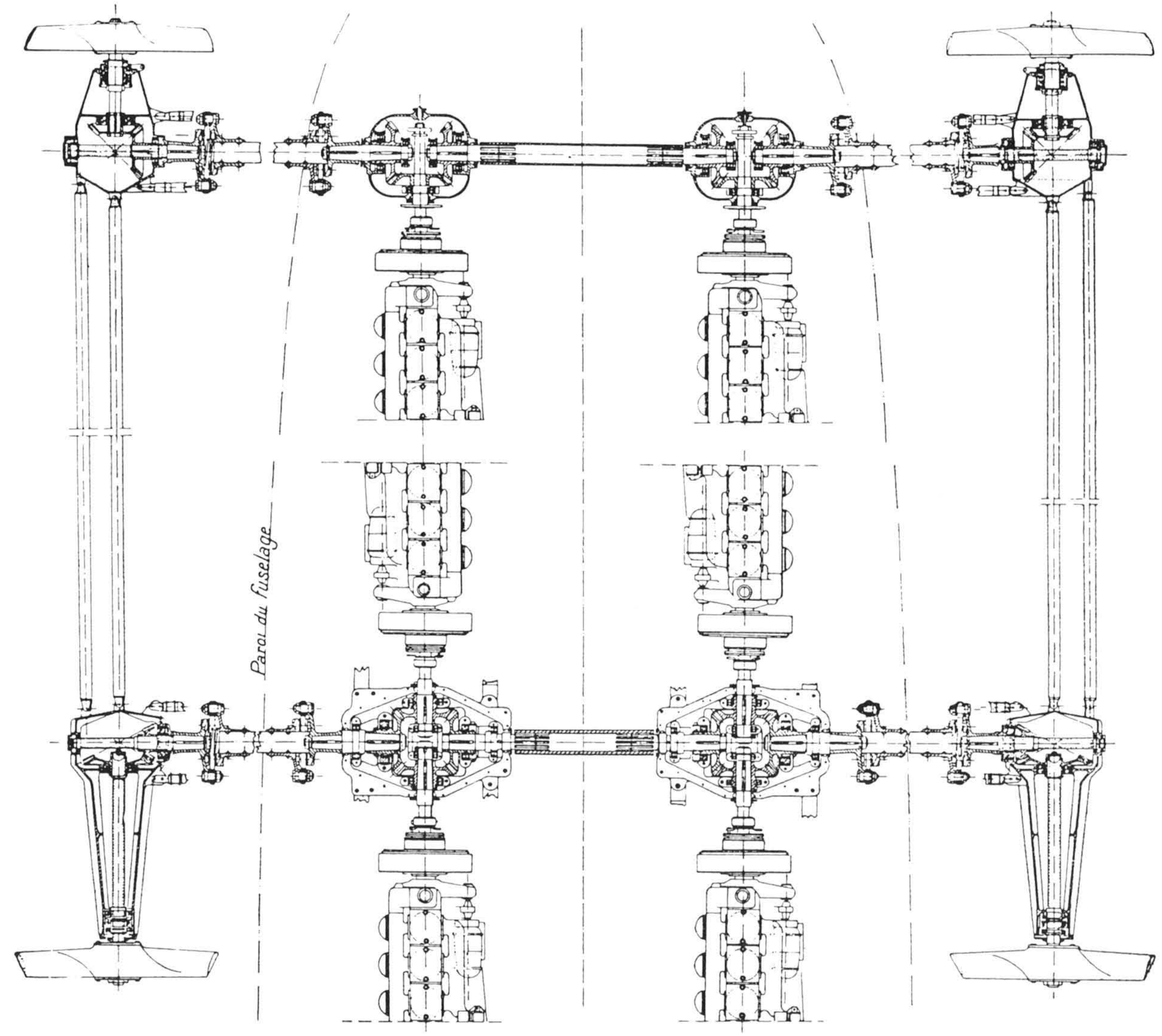
The specifications for the R.VIII called for a climb of 4500 metres in 120 minutes carrying a useful load of 5250 kg., and a speed of 130 km.h. was required at 2500 metres. Initially the R.VIII was to have been powered by six 260 h.p. Mercedes D.IVa engines, but these were dropped in favour of the



Early project drawing for the SSW R.VIII, dated 10 January 1917. The aircraft is powered by four buried engines driving two tractor propellers and two untended pusher engines.

new and more powerful 300 h.p. Basse & Selve BuS.IVa engines, which were in the process of becoming operational.

A full-size wooden mock-up was built, consisting of fuselage, centre wing section, gear-box, drive assembly and the various machine-gun positions. Photos show a fully-enclosed rotating nose turret believed to be the first of its kind, but it was not mounted in the finished aircraft. After examining the



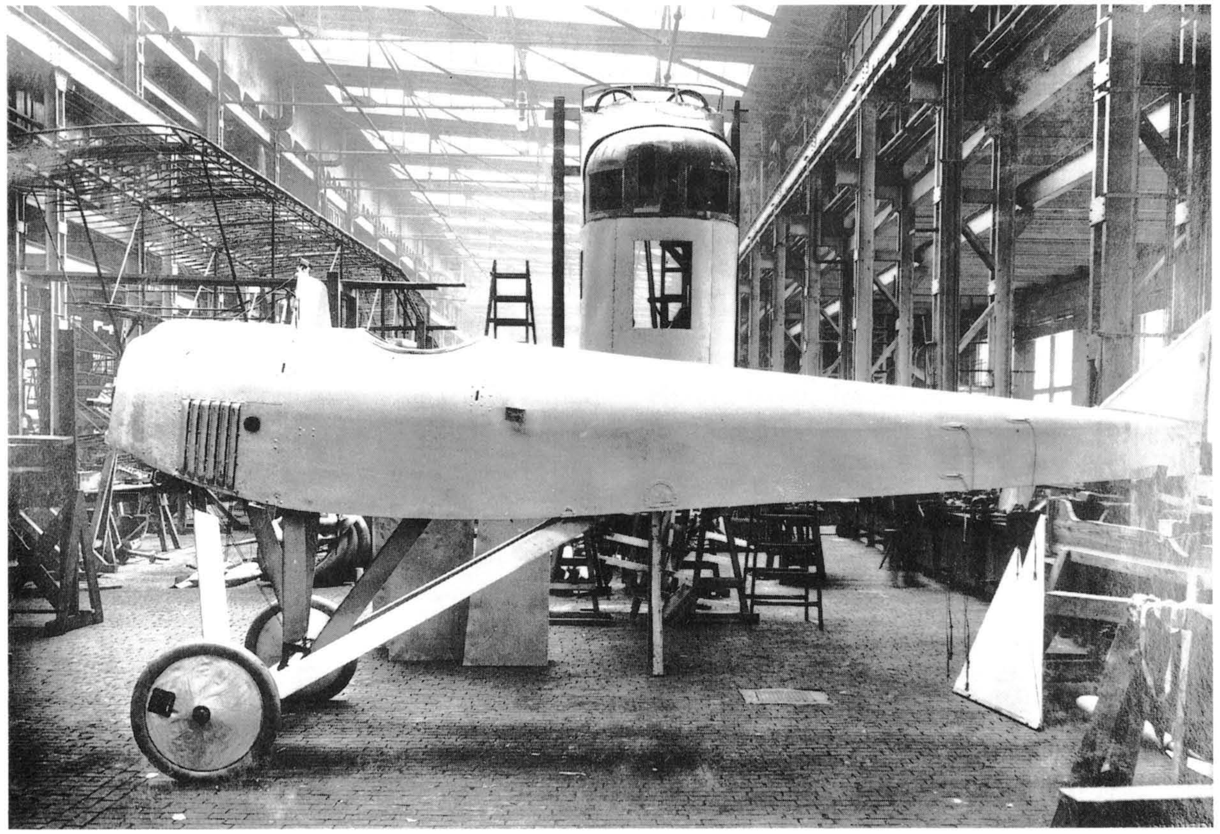
SSW R.VIII. Engine and power transmission arrangement. (Position of front engines is here reversed.)

proposed design, Idflieg engineers concluded that the fuselage was too short, and their recommendation to lengthen it by 2 metres was accepted. A second recommendation to place an additional machine-gun in the floor of the nose was rejected, as the R.VIII was intended for night bombing, and every ounce of weight was to be spared. A fully retractable gun position for rear defence, also under consideration at one time, was not adopted for the same reason.

The wooden mock-up was completed in the autumn of 1917, but because SSW engineers were heavily engaged in the design and construction of fighters, preparation of the working drawings was delayed. As a consequence, Idflieg assigned several full-time engineers to the R.VIII project. New calculations based on latest engineering developments and operational requirements necessitated increasing the wing area and the span to 48 metres. Because the Dynamowerk shops could not accommodate this size, a new assembly hangar was erected which was finished in October 1917. Work on

the R.23 began immediately, and by January 1918 the fuselage framework was assembled. Other parts, such as landing gear, controls and gear-boxes, were well advanced.

In January 1918 an Idflieg report stated that the R.23 would be flight-ready by the end of March, but by March the completion date had been put ahead to June 1918, and actually the assembly of the R.23 was still in progress in November 1918. The delay was due to the protracted delivery of the

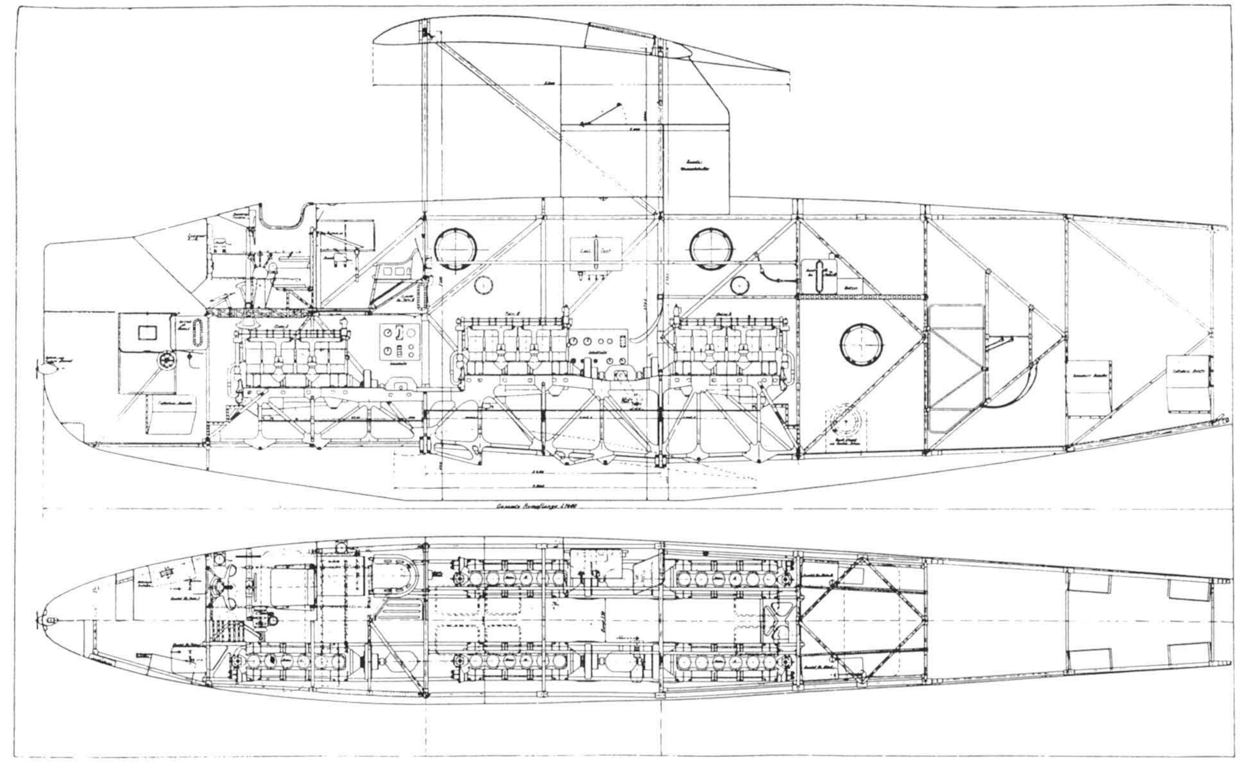


Mock-up of the R.VIII fitted with an experimental enclosed revolving turret can be seen behind the SSW E.I in the foreground. Photo dated April 1917.

BuS.IVa engines, which had difficulty in passing qualification tests and problems experienced with the drive and transmission system.

The six 300 h.p. Basse & Selve BuS.IVa engines were mounted internally in two rows of three engines, each separated by a broad cat-walk. The two backward-facing front engines were coupled to a common gear-box which drove two two-bladed tractor propellers through outrigger shafts. The remaining two pairs of engines, mounted face-to-face and also coupled to a common gear-box, drove two four-bladed pusher propellers. Operational reliability and long-range performance were the prime reasons for this unusual engine arrangement. The R.23 was designed to cruise using only the four rear engines after having released its bomb load and to fly in a shallow glide using only the two forward engines. Six individual combination friction and centrifugal-key clutches actuated by a hand-wheel provided means for separately engaging or disengaging the engines. The propellers were arranged in tandem and mounted on robust struts at a mid-gap position.

In a concerted effort to avoid a recurrence of the engine-cooling problems, SSW carefully investigated improved radiator designs and performed numerous flight tests in a Gotha bomber. Large circular water and oil radiators enclosed by a Venturi-type shroud were finally chosen. These were



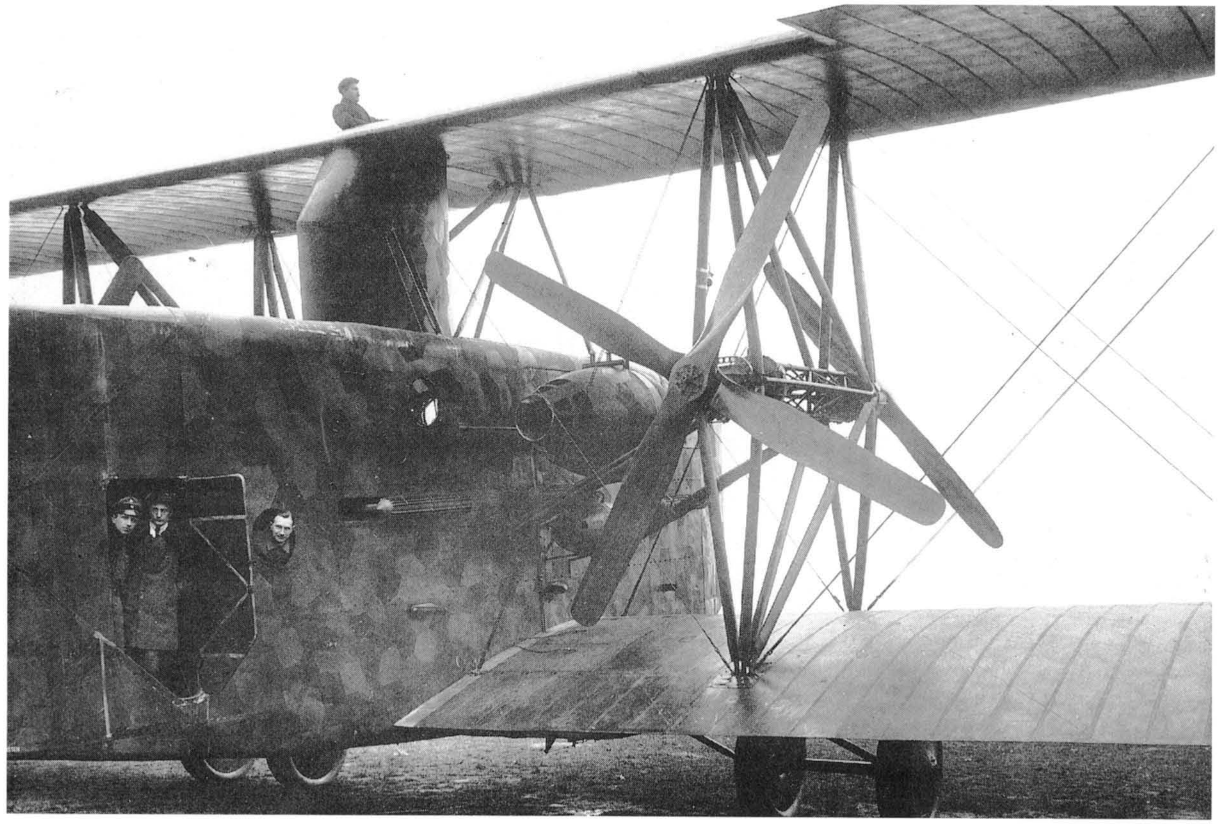
Internal layout of the SSW R.VIII.

based on the Junkers nozzle radiator principle, and besides being more efficient had the advantage that the airflow could be closely controlled for optimum cooling and prevention of boiling or freezing of the radiator water. Another improvement founded on previous experience consisted of placing the major portion of the exhaust stacks in the slipstream. The development of left- and right-hand engines had made this desirable feature possible.

In spite of having been increased in length, the bulky rectangular fuselage of the finished aircraft still appeared short in relationship to its broad wingspan. The steel-tube fuselage framework was braced with diagonal tubes throughout to provide greater rigidity. The nose and entire engine-room was metal-skinned, and the remainder was covered with fabric.

An observation/bombardier's cabin was located in the extreme nose, surmounted by a machine-gun

The fuselage of the SSW R.VIII shown ready for transport by road to Döberitz. Photo dated 17 October 1918.



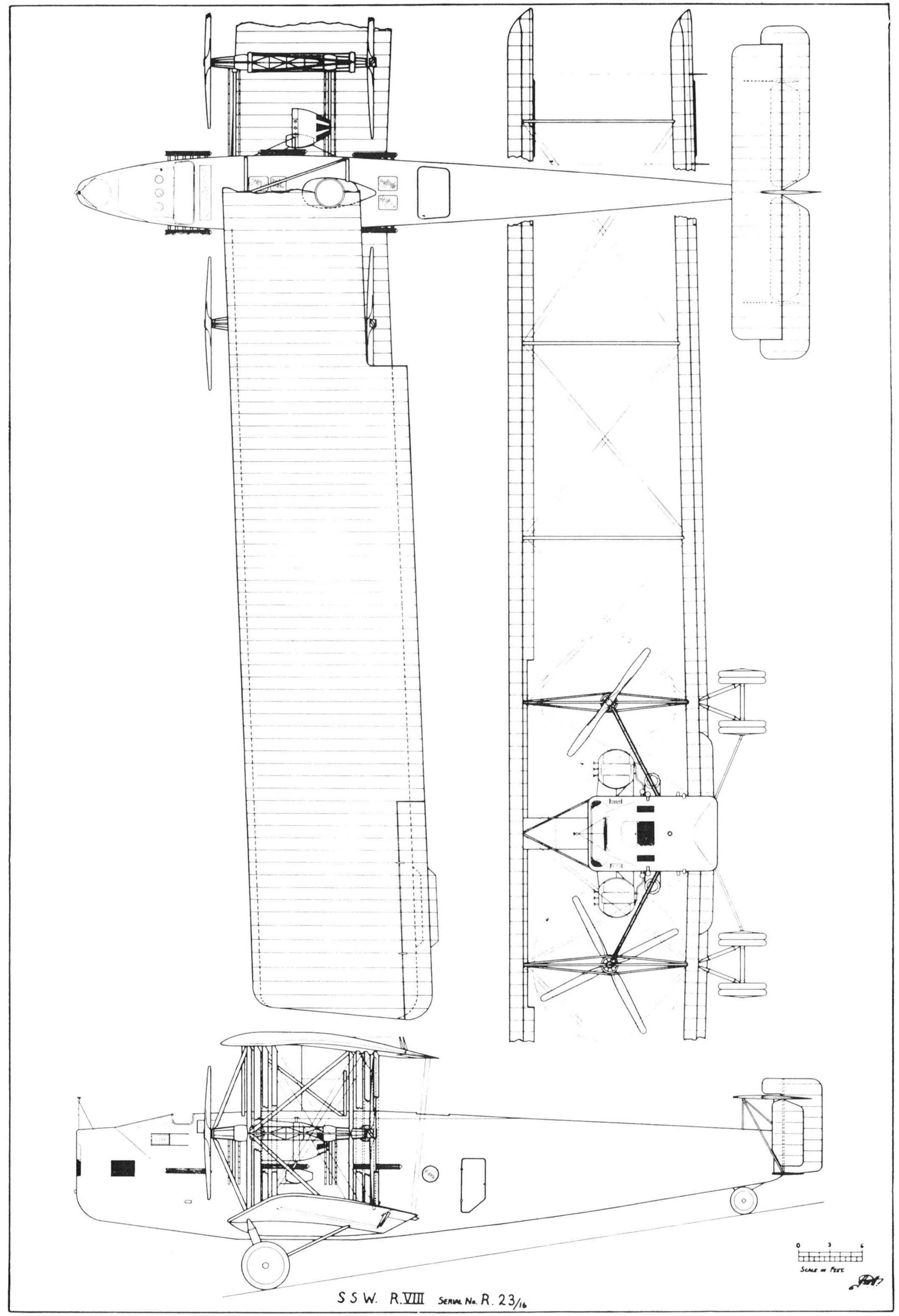
SSW R.VIII 23/16.

position. The open cockpit for two pilots was situated directly over the front engine pair and commanded a fine view to all sides. A fully-enclosed cabin for the commander/navigator directly behind the cockpit contained a map table, compass, navigation equipment and the like. The large engine-room stretched from below the cockpit to a few feet behind the trailing edge of the wing. It was ventilated by windows in the upper decking and by portholes in the side of the fuselage. The engine-room was followed by a wireless cabin containing receiving and sending gear, Bosch power supply, aerial spool and associated equipment. The dorsal gun position, located above the wireless cabin, was intended for two machine-guns mounted on brackets on either side. A ventral gun position for a prone gunner was located in the compartment behind the wireless cabin.

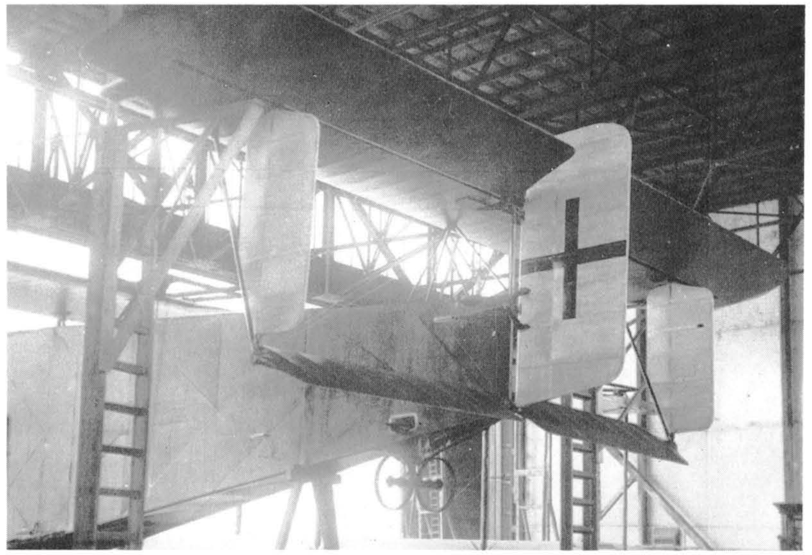
An unusual feature which the R.VIII shared with the Schütte-Lanz R.I was the streamlined enclosure which protected the ladder leading to the upper wing machine-gun post. It also contained a gravity tank in which additional engine cooling water was stored. Parachutes were stored in the nose compartment and near the rear exit door.

The huge four-bay wings constructed primarily from wood were carefully designed to achieve highest strength-to-weight ratio from the wooden spars and ribs. The fuel tanks were located in the lower wing roots outboard of the fuselage, and contained sufficient fuel for 8 hours flying time. Protection from gunfire was provided by a fire-proofing system devised by Prof. H. W. Fischer, but further details on this are unknown.

Ailerons were mounted on both upper and lower wings, and these marked the sole appearance of the newly-developed and patented Flettner servo-controls or trim tabs in R-planes. The inventor, Anton Flettner, began his career prior to the war, when he attempted to devise a remote-control device using "Herzian" waves for circus horses. It was to be a sensational finale in the Schumann Circus, but the horses refused to co-operate under the load of a radio-equipped saddle that punched and pricked! At the beginning of the war Flettner's ingenuity came to the attention of the ever-

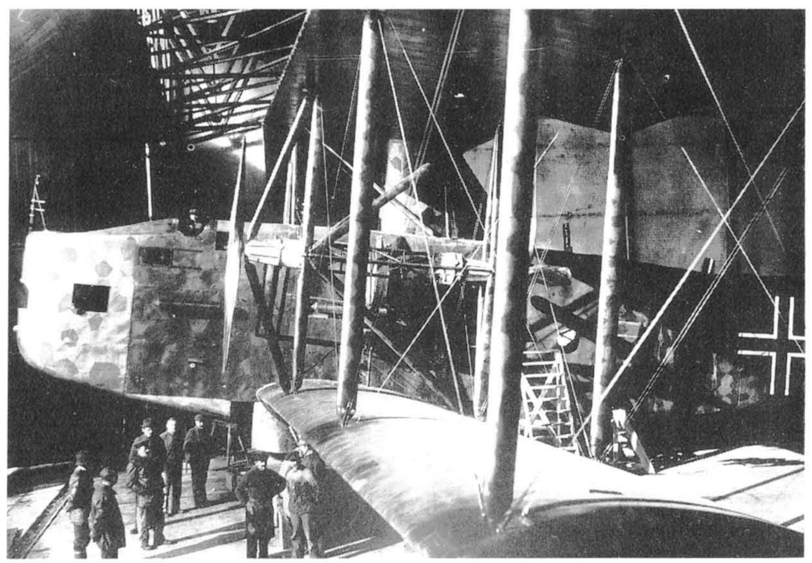


visionary Graf Zeppelin, who put Flettner to work investigating the remote control of Zeppelins and flying weapons. In 1915 Flettner constructed a wireless remote-control miniature tank equipped with a flame cutter to sever barbed wire and iron stakes. The tank was demonstrated before short-sighted military experts, who saw no need for such a device, and the project was dropped. However, Idflieg,



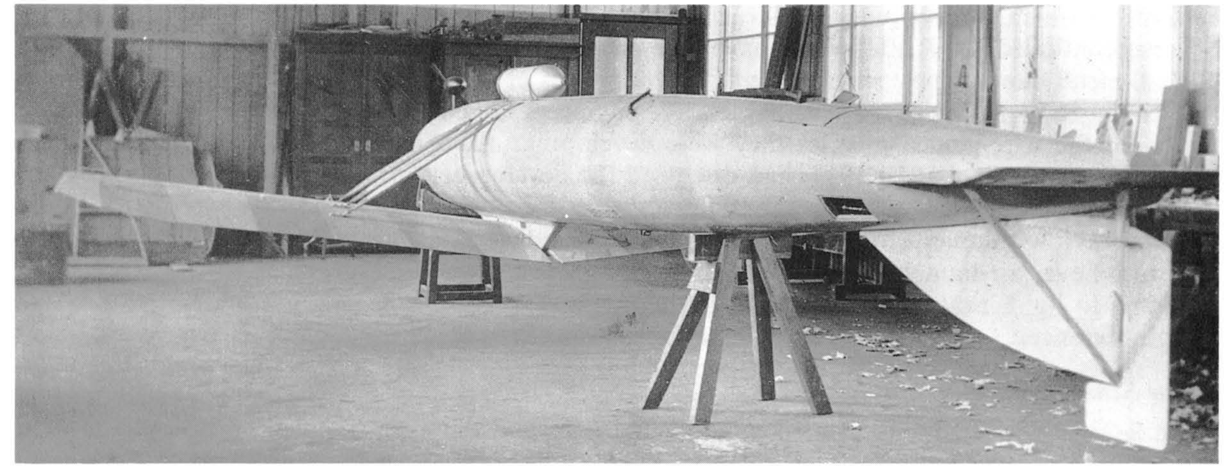
Tail unit of the SSW R.VIII 23/16.

recognizing the potential value of these experiments, engaged Flettner to investigate wireless remote-control systems for pilotless aircraft then under development by Idflieg. Writing in 1926, Flettner refused to divulge details concerning this interesting work, with one exception. It was during this time



The newly completed SSW R.VIII prior to leaving the assembly shed.

that the servo-control device was invented by Flettner as an aid to automatic control of pilotless aircraft. It was not long before this innovation was specified for all German bombing aircraft, but it came too late in the war to be widely used. SSW co-operated with Flettner in this work and con-



SSW experimental 1000 kg. wire-guided missile. Power for the controls was provided by the wind-driven generator mounted above the nose, behind which can be seen the container for the spool of guide wire.

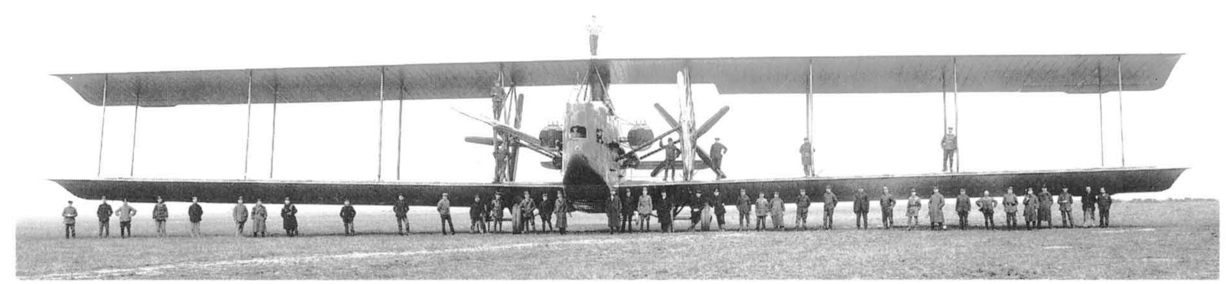
sequently was one of the first aircraft firms to employ the Flettner control surfaces. It was natural that the R.VIII should be equipped with this device.

Basically an improved version of the system used on the SSW R.I, the tail assembly was comprised of a single tailplane fitted with a balanced elevator. A pair of auxiliary elevators were mounted below the tailplane and gave the tail unit a false biplane appearance. A large central rudder was hinged to the fuselage and also was equipped with two small auxiliary rudder surfaces located in the gap between the elevators. A simple and robust undercarriage used spring shock absorbers, and was similar to the undercarriage of the earlier SSW R-planes.

The war ended before the R.23 was completed, but work continued under the sanction of the German Government, which wanted to explore its potential usefulness as a commercial transport. On 1 March 1919 the R.23 left the assembly hangar under its own power and performed various taxying tests. At the request of Lt. Offermann, the R.23 test pilot, the couplings between the port and starboard engines were disconnected for the projected test flights. On 6 June 1919, with the full flight crew aboard, the R.23 was undergoing engine tests with the rear engines at 800 r.p.m. (propellers at 400 r.p.m.) when the port rear four-bladed propeller flew apart, severely damaging the aircraft. The port upper wing collapsed, the propeller support struts were torn and bent, and the gear-box and lower wing were damaged, but the fuselage remained virtually intact. At first it was planned to use replacement parts from the R.24, but on 26 June 1919 the Government cancelled the repair work of the R.23 and the completion of the R.24, which was about three-quarters finished.

On 24 July 1918 three additional improved bombers designated SSW R.VIIIa, numbered R.75 to R.77, were ordered, and preliminary construction work begun in November 1918 ceased at the end of the war. A significant change was to equip the R.VIIIa series with Brown–Boveri turbo-superchargers driven by a 160 h.p. Mercedes D.III engine.

The SSW R.VIII was the largest aircraft built by any nation during the war. As such, it represented



The great size of the SSW R.VIII is evident in the above view.

the limit to which wooden wing construction could be efficiently taken. Had the development of R-planes continued, the R.VIII would have been rapidly surpassed by the Junkers, AEG, Staaken and SSW all-metal monoplanes, which were at various stages of design at the war's end.

After the SSW R.IV proved unsuitable SSW engineers hoped to be able to use the R.VIII as a carrier for the wire-guided missiles they were developing. As a matter of fact, Rea and Siemens engineers, as early as August 1917, had discussed the development of radio-controlled glide-bombs weighing between 300 and 1000 kg. The controls were to be based on the Flettner patents. SSW did build several low-silhouette monoplane gliders that could fit under the wings of the R.VIII; however, they were never air-launched and all work on the project ceased in December, 1918. Recently it has come to light, that Idflieg was considering using R-plane borne parasite aircraft to provide in-flight defence.

Colour Scheme and Markings

The R.23 was covered with printed camouflage fabric, and the metal-skinned portion was painted to match the printed polygons of the fabric. The under surfaces of the wings and fuselage were painted in a light colour. Narrow Latin crosses edged in white were carried on the wingtips and on the fuselage sides. The three rudder surfaces were painted white and the central one bore a straight black cross.

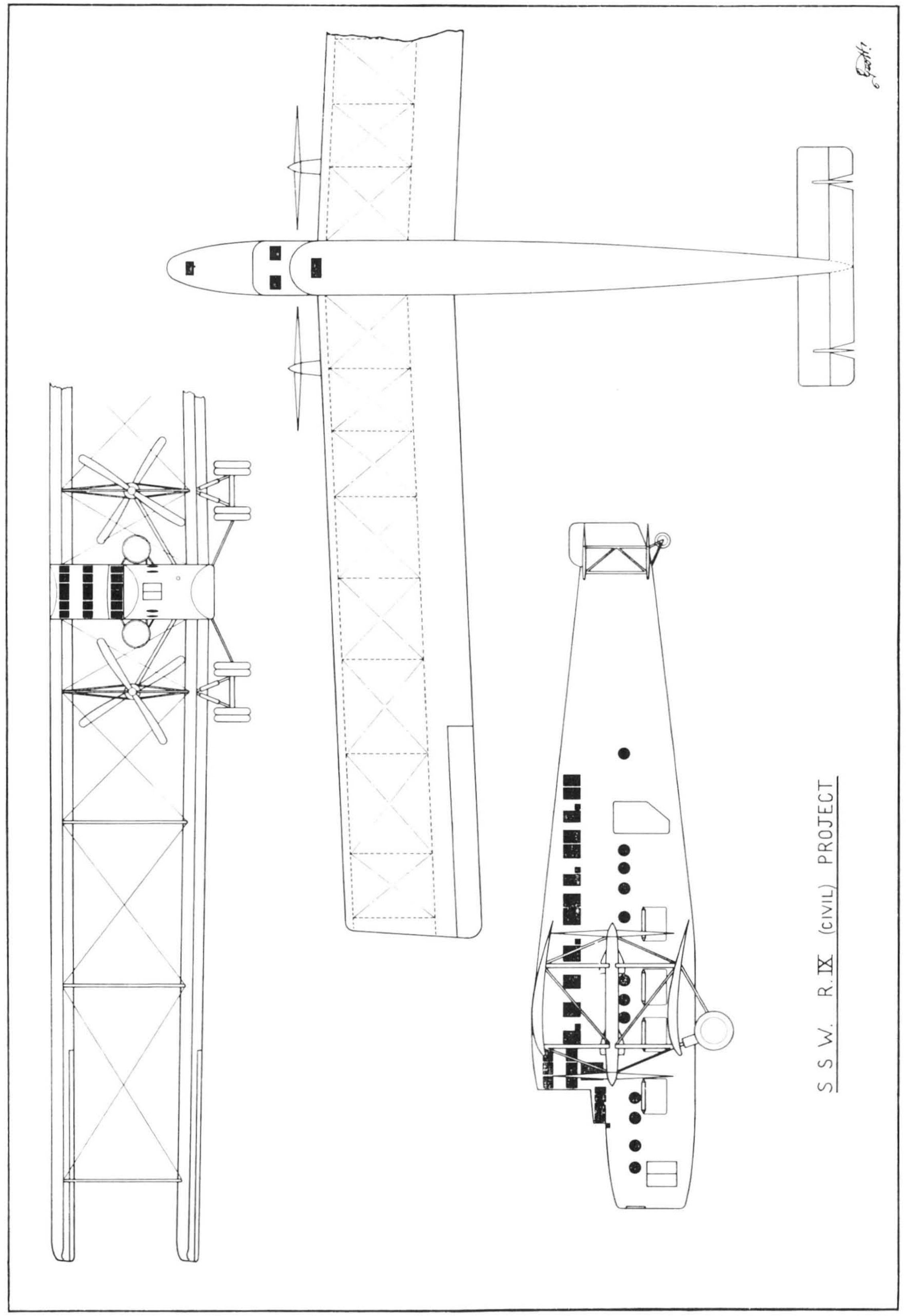
SPECIFICATIONS

Type:	SSW R.VIII
Manufacturer:	Siemens-Schuckert Werke G.m.b.H., Siemensstadt, Berlin
Engines:	Six 300 h.p. Basse & Selve BuS.IVa engines
Propeller Revolutions:	Tractor, 900 r.p.m.
	Pusher, 700 r.p.m.
Dimensions:	Span, 48 m. (157 ft. 6 in.)
	Chord upper, 5·2 m. (17 ft.)
	Chord lower, 4·5 m. (14 ft. 9 in.)
	Gap, 5·2 m. (17 ft.)
	Sweepback, 2¼ degrees
	Length, 21·6 m. (70 ft. 10 in.)
	Height, 7·4 m. (24 ft. 3 in.)
	Maximum fuselage width, 2·2 m. (7 ft. 3 in.)
	Propeller centres, 7·6 m. (24 ft. 11 in.)
Areas:	Wings, 440 sq. m. (4734 sq. ft.)
Weights:	Empty, 10,500 kg. (23,152 lb.)
	Loaded, 15,900 kg. (35,060 lb.)
Wing Loading:	35 kg./sq. m. (7·2 lb./sq. ft.)
Performance (Est.):	Maximum speed, 125 km.h. (77·7 m.p.h.)
	Ceiling, 4000 m. (13,124 ft.)
	Range, 900 km. (559 miles)
Cost:	750,000 marks

SSW R.IX

The successor of the R.VIII was to have been the SSW R.IX, which was in the project stage at the time of the Armistice. Idflieg had already assigned the military number 204/16 to the project, and although it started as a bomber, SSW changed the design into a passenger transport capable of carrying thirty-six including the crew.

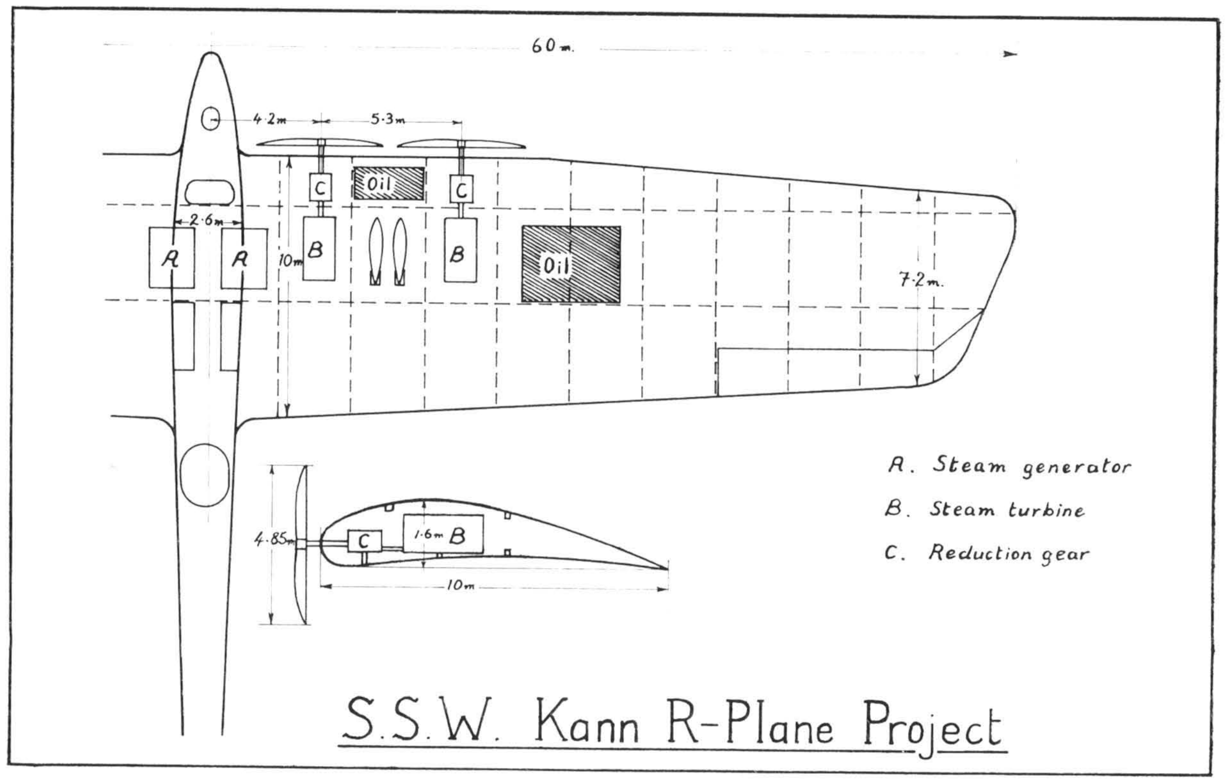
As a passenger transport, the R.IX was divided into two decks; the lower deck contained a nose baggage compartment followed by a large engine-room for eight 300 h.p. Basse und Selve BuS.IVa engines. The tractor and pusher propellers were driven by four engines, each coupled to a common gear-box exactly like the pusher-drive configuration in the R.VIII. A combined buffet and lounge was located behind the engine-room, with steps leading up to the rear of the passenger deck. The seats for twenty-four passengers were placed two abreast, separated by an aisle which provided access



to a passenger's observation deck located ahead of the wings above the commander's navigator's compartment. The fully-enclosed pilots' cabin was situated above the front pair of engines and provided good visibility to all sides. In all other respects the R.IX was basically an enlarged version of the R.VIII. Specifications regarding the R.IX are not available.

SSW Kann Project

In 1918 SSW became interested in a unique project by an engineer named Kann, for an R-plane powered by steam turbines. Two oil-fired steam generators were to be located in the fuselage, and the steam fed to four turbines mounted in the monoplane wings, and driving four tractor propellers at 800 r.p.m. via gearboxes. There must also have been some form of condenser unit to reclaim the steam, but unfortunately this is not shown in the drawing. It was estimated that the four turbines would develop a total of 3000 h.p., and enough oil was to be carried in wing tanks for 5½ hours flight. The wings, which had an area of 500 sq. m. also housed bays for 3000 kg. of bombs. Total laden weight of the machine was to be 25,000 kg.



Staaken

The most successful of the German R-planes were those built by the Zeppelin-Werke Staaken, G.m.b.H. (Staak.). They were built in greater numbers than any other type by the parent firm and several licensees; they were the only R-planes to see action on the Western Front, and the heaviest bombs dropped on Great Britain during the war were carried by Staaken machines. Indeed, the Staaken R-planes were the largest aeroplanes to raid England in both World Wars.

The genesis of the Staaken types goes back to before the outbreak of hostilities. As mentioned in the Introduction, in the summer of 1913 Hellmuth Hirth had planned to build an aircraft capable of spanning the Atlantic. Queried on this point here is an excerpt from a letter Hirth wrote in 1928:

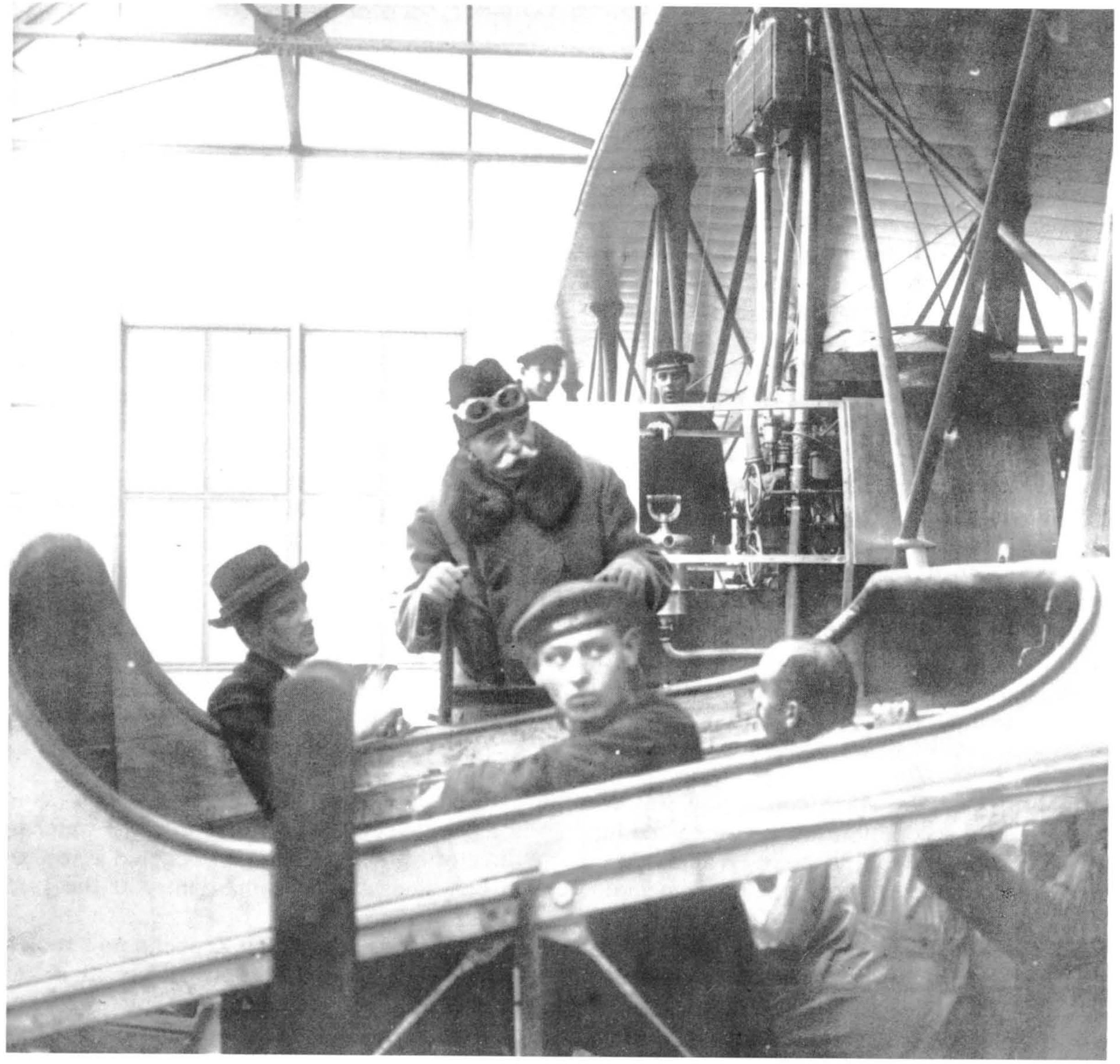
> It is true that I developed an R-plane project in 1913 with which I intended to cross the Atlantic in 1915 and then fly on to the San Francisco World's Fair. The financial backing was guaranteed by Direktor Gustav Klein of the Robert Bosch Werke. Consequently, I negotiated with the Maybach firm to provide 250 h.p. engines, of which a total of eight were to be built. Four were to be tested in a speed-boat and improved according to experience, the other four were intended for the aircraft. I proposed a large biplane, of 43 metres span and 18 metres length with twin floats each supporting an engine nacelle connected by shafts to the floats. All the necessary flying and engine controls were mounted in a central fuselage that projected forward from the lower wing. The wing rib profile was thick enough to enable crew members to crawl into the engine compartments. The navigation instruments, main fuel tanks, as well as the pilots' seats were installed in a highly sea-worthy duraluminum boat. The wireless generator engine could be connected to the boat's propeller. This light-weight boat could be lowered from the bottom of the central fuselage by means of winches.

The purpose of the Hirth conception was two-fold; the engines could be serviced in flight (as in airships), and secondly, in case of a forced landing, the nacelle could be lowered into the water to substitute as a powered lifeboat. Wilhelm Maybach, director of the Maybach Works, had agreed to donate the engines, which, still experimental, were to be tested in the German entry at the 1915 Monaco speed-boat races.

But World War I exploded, smashing peacetime dreams. The visionary Graf Zeppelin now took a deep and lasting interest in the Hirth–Klein project, for in it he saw a weapon of vast potential. At that early date the operational limitations of dirigibles were already realized by Graf Zeppelin: obviously their inflammability, cumbersomeness, vulnerability, and relatively slow production rate precluded their use as an all-round weapon; their only real value lay in long-range reconnaissance. Furthermore, after the tragic loss of the Navy Zeppelin L.2 in 1912 Navy engineers began to take a firm hand in the design of future airships, and Graf Zeppelin, who in addition could not get along with Admiral von Tirpitz, the Navy chief, began to lose interest in his creation. At the outbreak of the war the Zeppelin concern became a national asset and was expanded rapidly under military pressure and dominance. By then the Graf was far removed from the actual day-to-day operations of his concern, and he sought other outlets for his boundless energy.

His main preoccupation became long-range bombers, made even more tempting by an unusual theory advanced by an engineer friend who had convinced Graf Zeppelin that a 1000 kg. bomb dropped into English harbours would create underwater compression waves that in turn would crush the hulls of harbour-bound ships. Soon after hostilities began, the Graf asked Alfred Colsman, then Director of Luftschiffbau Zeppelin G.m.b.H., to build an aircraft capable of carrying a 1000 kg. bomb over a 600 km. range. Although small-scale tests soon proved the "bomb in harbour" theory false, Graf Zeppelin continued to be the driving force behind giant bombers, almost to the exclusion of his other interests.

Inasmuch as airship construction had a high priority, Colsman was very cool towards launching a new venture. The diversion of effort required to build an R-plane was unpatriotic, Colsman argued.


Graf Zeppelin and Anton Diemer, an engineer from the Bosch company, on the occasion of a visit to the VGO works, 22 February 1917.

and furthermore, the Zeppelin concern had never built aeroplanes of any kind, nor was space or experienced man power available. In spite of Colsman's arguments to the contrary, Graf Zeppelin, with obstinate zeal and singular persistence, persuaded Colsman to proceed.

It was at this juncture that Gustav Klein, Director of the Robert Bosch Werke, was asked to participate. The transatlantic project of Hirth and Klein had come to the attention of Graf Zeppelin, who was also impressed by Klein's organizational abilities. To obtain Klein's services Graf Zeppelin had to strike a bargain with Robert Bosch. Previously, Bosch had agreed to share in the design costs (and possibly construction costs) of the all-steel transatlantic airship on which funds had already been spent by Dornier's design office. Graf Zeppelin offered to relinquish his claim on Bosch's financial share if instead he could have Klein as the leader of the R-plane project. Evidently, Bosch himself wanted to build a giant aeroplane and use Klein as the organizer; but in the end, Klein and some thirty engineers, purchasing agents and master workmen were given leave of absence to join the Zeppelin venture.

Colsman, by now resigned to Graf Zeppelin's wishes, suggested that it would be wise for the Graf to use his influence and popularity to obtain Army and Navy support. Notwithstanding the War Office's disapproval of the project, Feldflugchef Major Thomsen (Chief of Field Aviation) and Admiral Dick, Chef des Werftdepartment in the Reichsmarine Amt (Chief of Naval Construction Bureau), gave their full support. Both services released trained personnel to work on the first machine, and the Navy placed a contingent order for two aircraft, although only one eventually entered Navy service.

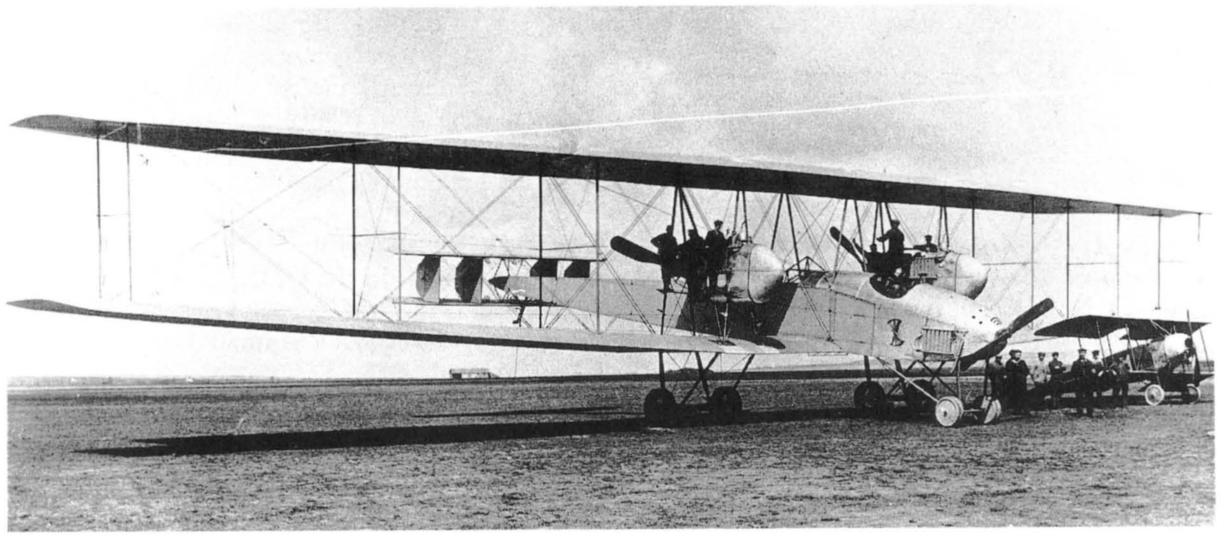
A corporation called Versuchsbau G.m.b.H. Gotha-Ost (VGO—Experimental Works Gotha-East) was formed, financed by Zeppelin and Bosch. Sheds were rented on the Gotha airfield, where the assembly of the giant bomber was to take place. In August 1914 Graf Zeppelin engaged Professor Alexander Baumann of the Technische Hochschule in Stuttgart to design and supervise the construction of the private-venture bomber. Baumann was named head of the VGO technical department, and in 1915 he became head of the R-plane design department of the Zeppelin-Werke Staaken, a position he held until 1918, at which time the engineers Hermann and Scholler were also listed as designers. Hirth joined the venture as the consultant for practical flying matters, while the soon-to-be famous Claudius Dornier and Ernst Heinkel were asked to join as assistant engineers. Dornier up to now had been working in Graf Zeppelin's private design offices on an 80,000 cubic metre all-metal airship with transatlantic range. Heinkel turned the offer down because he had just been named chief engineer of the Hansa-Brandenburgische Flugzeugwerke. Others who participated at various times were Dr. Adolf Rohrbach, who specialized in all-metal R-plane construction after an apprenticeship at Zeppelin-Werke Lindau (Dornier); Oskar Wilcke, who developed the electric bomb-release mechanism; and Graf Alfred von Soden as head of the Zahnradfabrik G.m.b.H. (a Zeppelin subsidiary), who along with the Swiss engineer Max Maag designed and built gears and clutches for Staaken, AEG, DFW, Aviatik, Schütte-Lanz and Dornier R-planes.

It was decided at the outset to work with two different construction materials: wood and metal. Wood was chosen because in using the existing conventional construction techniques it represented the fastest means for getting a bomber into the air. However, Graf Zeppelin, perceiving the enormous possibilities inherent in metal construction, detached Dornier to devote his full time to building all-metal giant aircraft. Dornier was given a small airship hangar at Seemoos on Lake Constance, where his experiments soon achieved remarkable success.

In September 1914 construction began on the wooden bomber in the rented sheds at the Gotha airfield under the cover name of Versuchsbau Gotha-Ost. It is an interesting sidelight and proof of British secret-service efficiency that information and plans of the first VGO aircraft reached Britain in early 1915. The acquisition of these drawings was publicized in British publications, which warned the Germans thereafter to be more discreet with their military secrets. The British Press continued to call the giant bombers, which later raided Great Britain, Super-Gothas, in spite of the fact that the Gothaer Waggonfabrik never built any giant bombers during the war.

VGO.I–RML.1

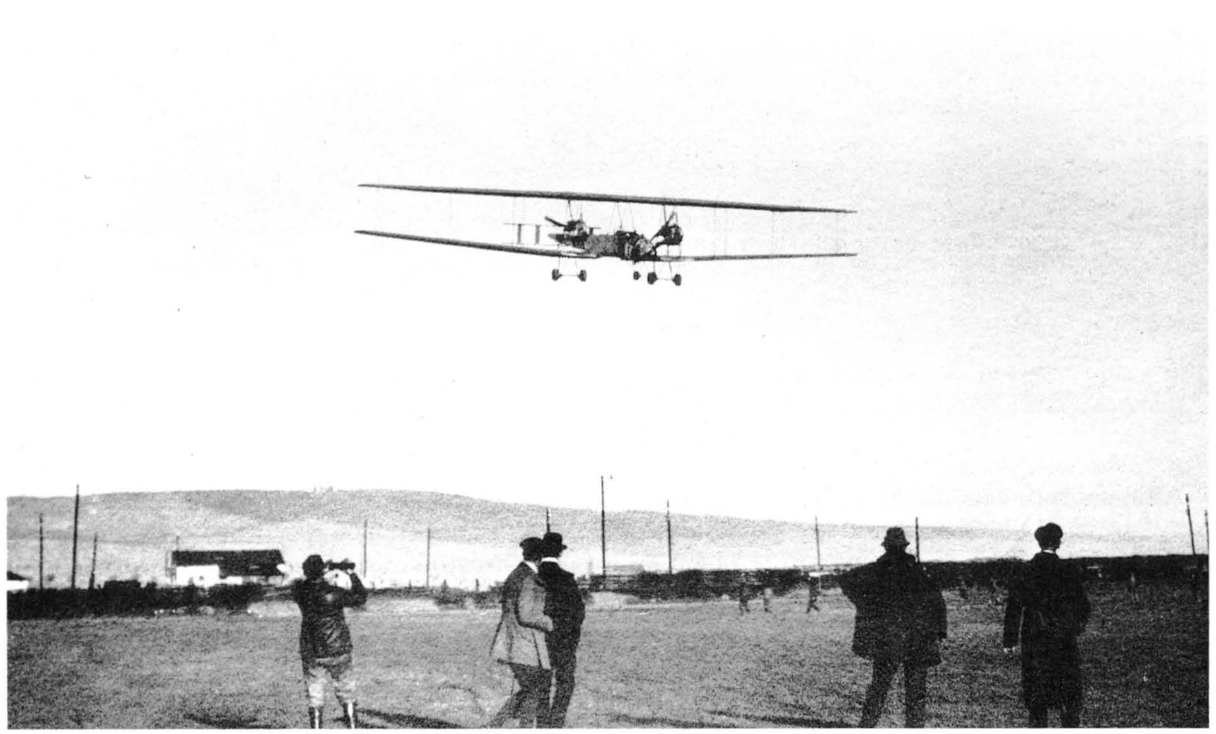
Although work on the VGO.I, as the first bomber was called by the Company, started in September 1914, final plans were not completed until December. Construction moved too rapidly, and in January 1915 work was temporarily halted to await delivery of the new 240 h.p. Maybach HS engines, which were to prove an unsuccessful aircraft version of the HSLu airship engine. Meanwhile interference came, of all places, from the Prussian War Office, which held it extraordinary that anyone besides themselves would dare take the initiative in weapons development, a field in which they alone considered themselves experts. Consequently, the War Office blocked the Graf at every turn, but the tenacious old gentleman, supported by Feldflugchef Thomsen and Admiral Dick, energetically pushed the project past all obstacles. Nevertheless, a nip-and-tuck race developed



The VGO.I shown in its original form during the spring of 1915. This machine was the ancestor of the Staaken line of R-planes.

between the completion date of the VGO.I and the patience of the military authorities which was slowly running out. The situation was such that detached military personnel working on the bomber were to be recalled and had but few days leave remaining when Hirth piloted the VGO.I on its maiden flight on 11 April 1915.

The flight crew consisted of two pilots seated in a large open cockpit, one commander/navigator and three mechanics, one for each engine. Their means of communication was very crude; it consisted of bell signals and blackboards upon which orders were written. An eye-witness also remembers Hirth signalling vigorously by hand to the mechanics in the outboard nacelles.

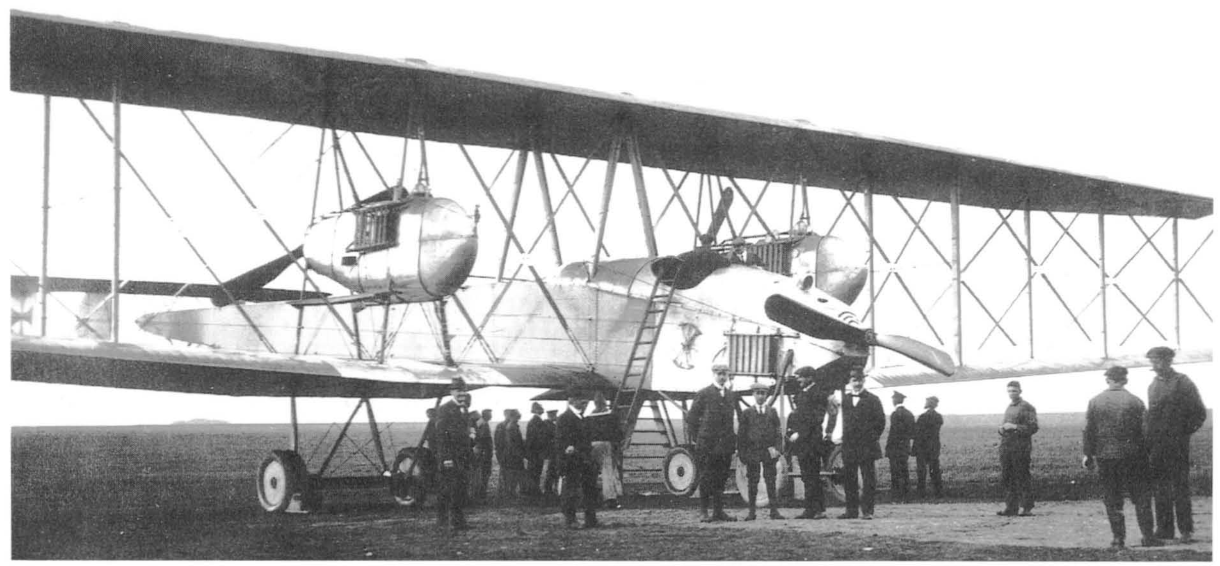


The VGO.I on its maiden flight at Gotha, 11 April 1915.

Three 240 h.p. Maybach HS engines were installed; one was mounted in the fuselage nose and drove a tractor propeller, the other two were mounted in nacelles, driving pusher propellers within the wing gap. Each nacelle was supported at mid-gap by a pair of inverted V-struts. In its original form the fuel tanks were placed in the nacelles ahead of the engines. Initially uncowled, the front of the nacelles were later covered by streamlined metal fairings. Cooling was provided by six Haegele & Zweigle radiators, one along each side of the nose engine and two similarly placed on each nacelle.

The four-bay wing structure with its swept-back leading edges and slight negative stagger set the basic pattern for all the Staaken designs that followed. Structurally, the wing was very similar to the Staaken R.VI type, and is described in detail in that chapter. Plain unbalanced ailerons were fitted to the wings.

Typical of its day, the fuselage was a slab-sided structure with a rounded top-decking extending forward from the large open dorsal cockpit behind the rear cabane struts to the nose. Aft of this decking the top and bottom longerons converged towards the tail to meet in a horizontal knife-edge. From the attachment point of the front cabane struts, the upper longerons were angled down towards



VGO.I. The double interplane cables are here shown faired without first being drawn together as they were on all later types. Standing in front of the aircraft are (from L. to R.) VGO engineers Hans Baumeister, Philipp Simon and Foreman Hungs.

the thrust line of the nose engine. The rectangular fuselage was of mixed construction, with four wood longerons and welded steel tubing frames; those in the forward part of the fuselage were reinforced with diagonal tubes. The fuselage was cable-braced and fabric-covered, with the exception of the plywood panelled top-decking and nose sides back to the pilots' position.

Provision was made for bombs to be carried in a cage at the centre of gravity, but the 1000 kg. bomb for which this aircraft was originally developed was not dropped by R-planes until 1918.

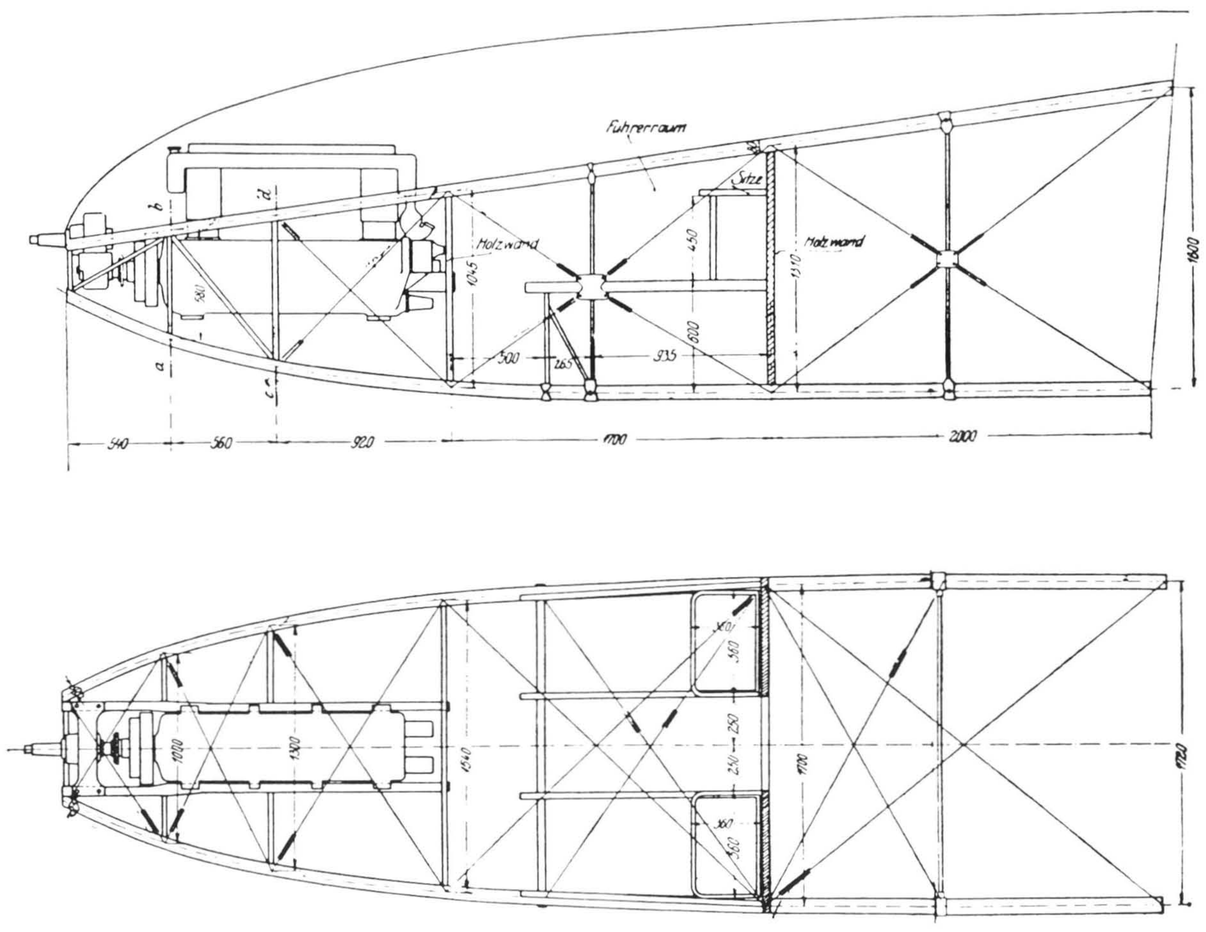
The biplane tail surfaces were located at a point slightly below mid-gap by a pair of V-struts above and below the fuselage. In its general form the tail cellule was of narrow gap and incorporated four small fins and unbalanced rudders spaced along the span. Plain elevators were fitted to both upper and lower tail surfaces. The control cables passed along the outside of the fuselage to large quadrants at the cockpit.

Two simple V-type undercarriages, each with four wheels arranged in pairs, were positioned under the nacelles. A similar undercarriage of lighter construction was mounted beneath the nose. Unlike the later Staaken machines, the VGO.I rested on its nose wheels when fully loaded. This brought the wings with their large angle of incidence into take-off attitude.

The Maybach HS engine which powered the VGO.I was developed from a line of successful

airship engines, but in the process of redesign and weight reduction it had fared badly. Beset by continual operational failures, particularly overheating at high revolutions during take-off, the HS engine was responsible for substantial delays of the Staaken and SSW R-plane programmes; designers were eventually forced to resort to less powerful but more reliable engines.

On 6 June 1915 the VGO.I made its first long cross-country flight from Gotha to the Maybach Works in Friedrichshafen. It took six months, until the winter of 1915, to provide the VGO.I with sufficiently reliable HS engines so that the Navy duration and acceptance flights could be flown in



Forward engine arrangement of the VGO.I and VGO.II.

Friedrichshafen. On 15 December 1915 while on the return flight to Gotha with Hans Vollmöller and Flugmaat Willy Mann at the controls and Hirth as aircraft commander, the VGO.I ran into a severe snowstorm over the Thüringen Forest. Due to a failure in the oil lines, two of the three engines had cut-out. As it was impossible to maintain height on one engine, the crew had no choice but to make a forced landing. With exemplary skill they put the machine down in a small forest clearing at Geroldsgrün, with heavy damage to the aircraft but with no injuries to the crew.

This marked the end of nine months' sustained effort to get the new Maybach HS engines running properly in an equally untried airframe. The team of engineers at Gotha were not discouraged by this unfortunate crash. They collected the remains and rebuilt the machine incorporating many new features. Profiting by the experience gained in flight testing the VGO.I, some of the improvements had already been built into the VGO.II, which had been completed by this time.

As reconstructed, the VGO.I had cowled engines with gun positions for a gunner/mechanic in the front of each nacelle. The interplane struts were faired, replacing the plain tubes of the original

Appearance of the VGO.I in the autumn of 1915, with modified nacelles and new tail unit.

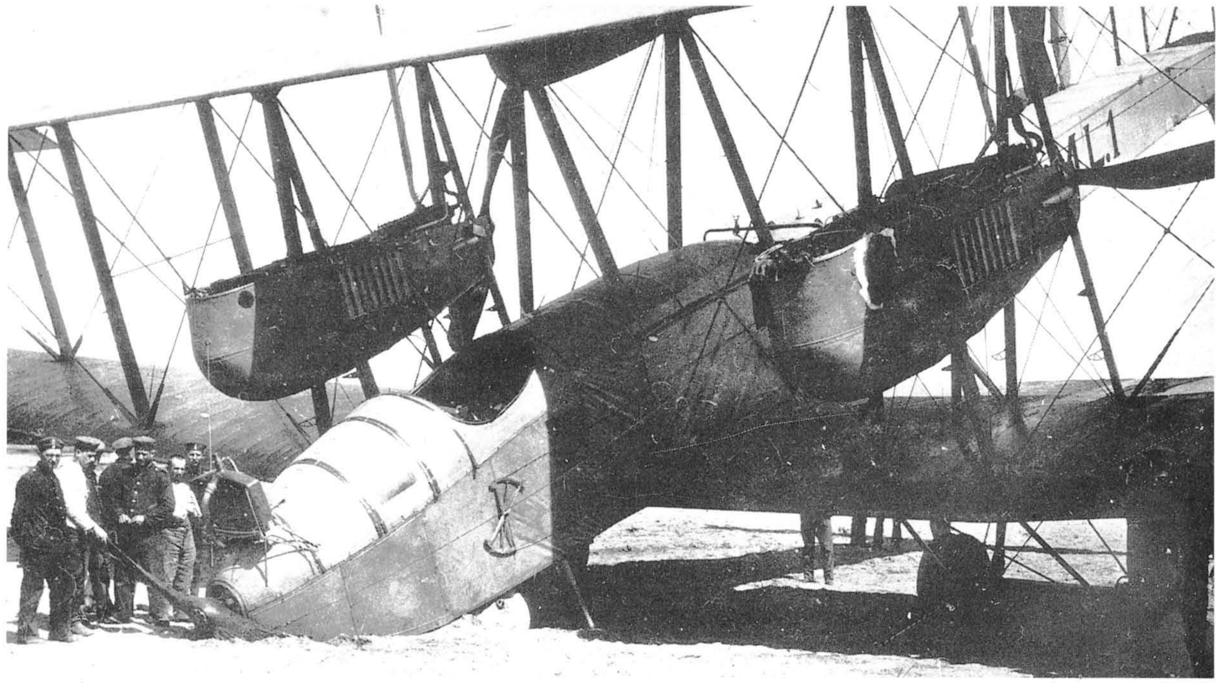
machine. A large streamlined gravity tank, which was to become a permanent feature of later types, was built into the top of the centre-section cabane. A single radiator was fitted on the top of the nose for the single tractor engine; the pusher engines retained their twin H & Z radiators. The original tail unit had proved to be rather inadequate for directional control. It was replaced by one similar to that on the VGO.II, except that the fin area was increased and rudders balanced. The HS engine was not replaced, for it was still the most powerful aircraft engine available; yet in spite of countless improvements and modifications, it was never equal to the task set before it.

The rebuilt VGO.I first flew on 16 February 1916. It was later accepted by the Navy and then assigned to Navy Kommando L.R.1, a special group formed under the command of Lt.z.S. Ferdinand Rasch to evaluate the new weapon on the Eastern Front. The letters RML.1 painted on the fuselage side stood for Reichs Marine Landflugzeug 1 (Reich Navy Landplane 1). Commanded by Rasch and flown by Navy pilots Lt. d. R. Carl Kuring and Flugmaat Willy Mann, the RML.1 left Gotha for Alt-Auz in June 1916. It took two months to complete the trip that was normally a three-day flight. The trip to Döberitz was uneventful, but an unscheduled landing was made *en route* at Schneidemühl to perform minor engine repairs. Several days later during the take-off run, the nose landing gear broke away and the machine came to rest on its nose. The small damage was promptly repaired and the RML.1 was on its way to Alt-Auz when overheating engines (made known to the pilots when the nacelle engine mechanics held up their

Hellmuth Hirth's crash with the VGO.I in the Thüringen Forest, 15 December 1915.

blackboards with the high temperatures chalked in large letters) forced an emergency landing on a small airfield near Königsberg. New engines had to be installed. All was in readiness when, shortly before becoming airborne, the main undercarriage collapsed and the RML.1 slid to a stop on its belly. Extensive and time-consuming repairs were required, but the newly-installed undercarriage was still not robust enough, and it collapsed again on the next take-off attempt. Finally, at the end of July 1916 the RML.1 reached its destination at Alt-Auz. What today may read like a comedy of errors was regarded at the time with much misgiving by the crews flying these early unreliable and cantankerous R-planes. They greatly preferred to be aloft in a single-engined combat machine of proven worth.

According to the Kommando L.R.I. War Diary, the first bomb raid was made on 15 August 1916, after an abortive start on 13 August, when it was to have attacked in company with the Army R-plane



Mishap with the rebuilt VGO.I (RML.1), during the take-off at Schneidemühl for the journey to Alt-Auz, June 1916

(VGO.II), then also stationed at Alt-Auz. The War Diary lists four bomb raids: the rail terminal at Schlok (15 August), the Russian air station at Lebara (16 August), the air station at Runö Island and troop encampment at Kemmern (17 August), and a cancelled raid on Kemmern (24 August) due to boiling left nacelle radiator shortly after take-off. On these raids the RML.1 carried a store of bombs that varied according to the mission. Against air stations it carried 6 × 50 kg. (Karbonit), 8 × 20 kg. (Karbonit), and 4 × 10 kg. incendiary (Goldschmidt) bombs. For attacks against troop installations 32 × 12 kg. (Karbonit), 21 × 20 kg. (Karbonit) and 9 × 10 kg. incendiary (Goldschmidt) bombs were carried.[1]

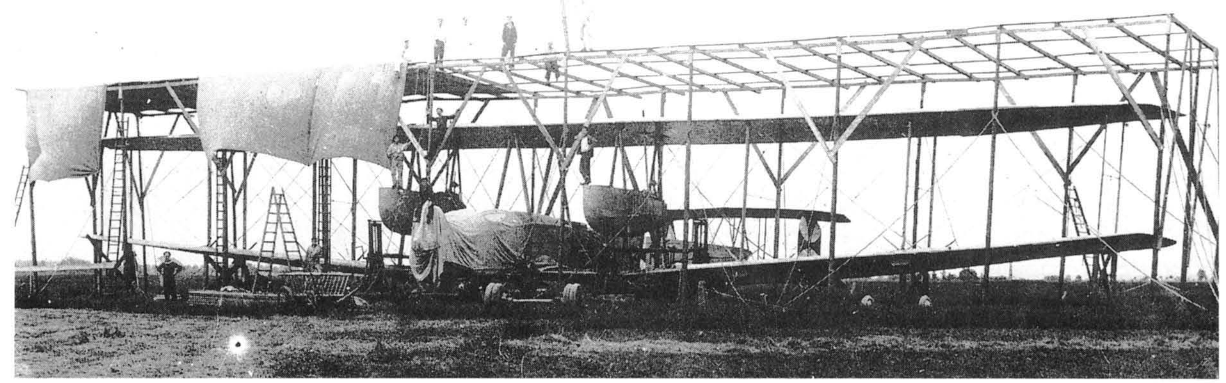
Pasted into the last pages of the War Diary is a short telegram from the Commander of the Baltic Sea forces to the Navy Staff dated 1 September 1916 saying that the "RML.1 has in the meantime been damaged". Here is what had happened. It was night; pilots Kuring and Mann were at the controls and the RML.1 had just taken the air fully loaded with fuel and bombs. The machine was straining for altitude when at 50 metres two of its engines, one after the other, "exploded". Having no choice but to go down, the pilots guided the aircraft gently into the pine forest below; although

[1] See Eastern Front Operations for further details of these raids and Appendix 12 for information on bombs.

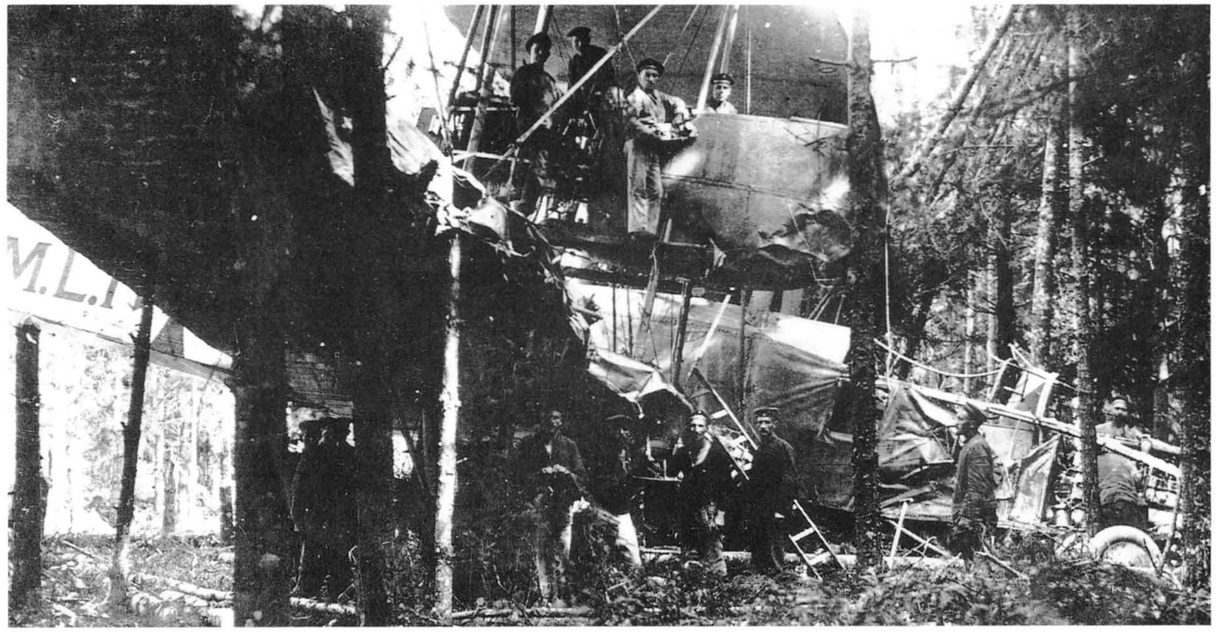
A further mishap to the RML.1 *en route* to the Front. Undercarriage failure on the airfield at Königsberg.

sixty-nine trees were sheared off, the dense foliage lessened the impact of the crash, which saved the RML.1 from destruction by explosion or fire. Only the fuselage was worth salvaging, and it was sent back to Staaken to receive new wings and engines. The Kommando L.R.I. was disbanded, its members received other assignments and everyone was relieved that the career of the unpredictable RML.1 was finally ended—or so they thought.

It was decided to rebuild the underpowered RML.1 by replacing the original three engines and increasing their number to a total of five 245 h.p. Maybach Mb.IVa engines, one in the nose and two



Temporary shelter erected over the RML.1 while under repair at Königsberg.



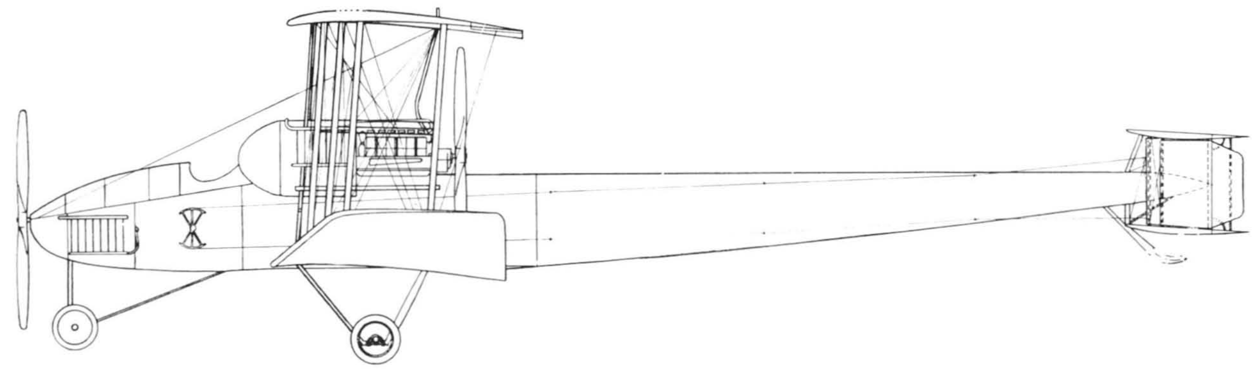
Crash of the RML.1 in the forest near Alt-Auz on 28 August 1916.

in each nacelle geared to a single four-bladed propeller.[1] The Maybach Mb.IVa, a vast improvement over the HS engine, had become available in late 1916, and it was the first of the "over-compressed" engines developed by the Germans for high-altitude use (see Staaken R.VI chapter for details). Standard slab-type radiators were fitted, those on the front struts being placed higher than the rear ones. The entire tailplane structure was raised to the top longerons and modified to have a single bay on each side. Like the Li-Ho R.I 8/15, the new fuselage and tail were entirely covered in Cellon in an attempt to make the machine partially invisible.

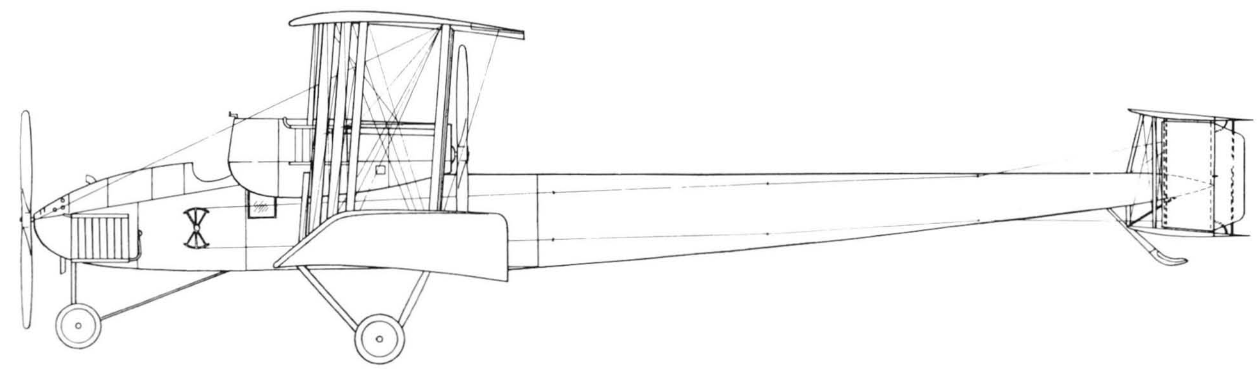
On 10 March 1917 the reconstructed VGO.I was readied for its maiden flight. The first pilot was Vollmöller, the second pilot was Kuring, who had been recalled from Marine Jagdstaffel 2. Rasch wanted to go along too, but Gustav Klein, who had been ordered by Bosch not to fly, jokingly told him to "stay behind and sweep up the pieces". Kuring stated that the VGO.I was still under Navy cognizance, which explained his presence and that of the other Navy personnel aboard. The take-off went smoothly, but as the VGO.I was circling the Staaken airfield a terrific detonation occurred in the left engine nacelle and the propeller stopped. The pilots immediately gave hard right rudder to compensate for the unequal thrust, and the machine responded well, flying a straight line to land parallel to the large airship sheds. Three days previously, while familiarizing himself with the controls, Kuring discovered and immediately reported that the rudder pedals were not functioning properly. In the hard-over position the pedals jammed and could not be returned to the neutral position. This fault had not been repaired. As Vollmöller cut the remaining engines preparatory to landing, the hard right rudder, robbed of its compensating force, slowly forced the VGO.I into a right turn. Kuring at once unfastened his safety belt and crept under the control panel to pull the rudder pedals over from their jammed position. It was too late. Vollmöller was helpless to prevent the VGO.I from reversing course and smashing head-on into the door of the airship shed. Vollmöller was killed instantly, and Klein died after a few hours. Kuring was thrown out by the impact, and though he suffered severe head injuries he was able to rejoin Marine Jasta 2 and thence enjoy a long and varied aeronautical career.

Graf Zeppelin had died two days earlier on 8 March 1917. Thus, in a span of three days, German R-plane development had lost three of its most important contributors, but serious as the loss may have been, their heritage was well founded. At that very moment the Staaken organization was

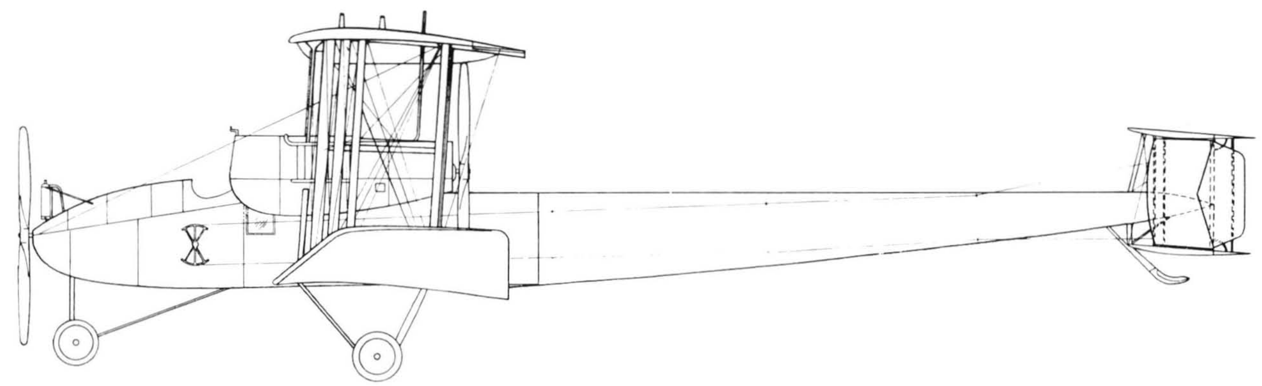
[1] One source claims that two 160 h.p. Mercedes D.III engines geared to a single propeller were located in the nose.



V G O. I. FIRST FLIGHT FORM SPRING 1915.



V G O. I. AUTUMN 1915

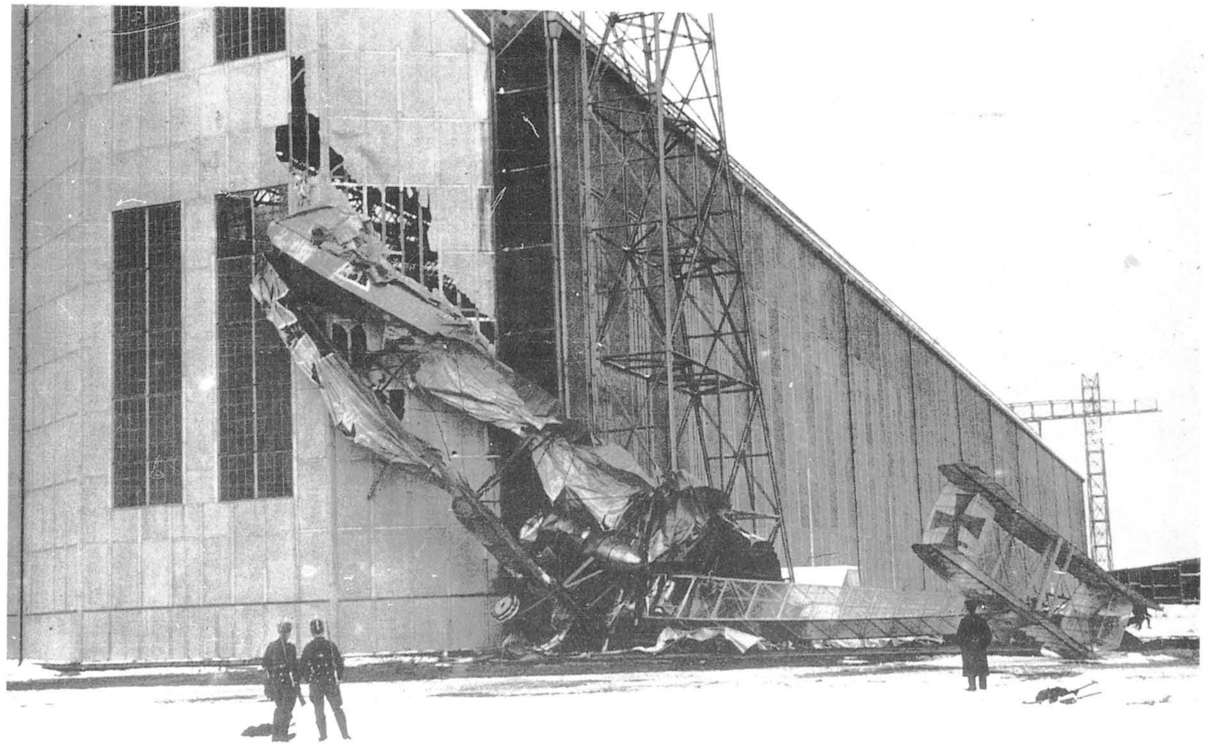


V G O. I. REBUILT AS THE R.M.L.1

building and testing new R-planes, destined to be the only giant bombers to enter operational service on the Western Front. It was the sustained efforts and enthusiasm of people such as Graf Zeppelin, Gustav Klein and Hans Vollmöller which made this achievement possible.

Colour Scheme and Markings

The VGO.I as it first flew carried no markings; it was clear doped overall giving it a pale buff colour. Later, the black Patée cross on a white square background was painted on the wingtips, fuselage



Wreckage of the final version of the VGO.I at Staaken. Both Hans Vollmöller and Gustav Klein were killed in this crash on 10 March 1917.

sides and rudders. The tail markings occupied the complete area of the vertical tail surfaces. The serial number RML.1 was painted on the fuselage after the VGO.I was taken over by the Navy. In its final form, with five engines, the markings conformed to the current style, that is the Patée crosses received thin white outlines.

SPECIFICATIONS

Type:	VGO.I–RML.1 (three-engined version)
Manufacturer:	Versuchsbau G.m.b.H., Gotha–Ost
Engines:	Three 240 h.p. Maybach HS engines
Dimensions:	Span, 42·2 m. (138 ft. 5½ in.)
	Length, 24 m. (78 ft. 9 in.)
	Height, 6·6 m. (21 ft. 7½ in.)
Areas:	Wings, 332 sq. m. (3572 sq. ft.)
Weights:	Empty, 6520 kg. (14,377 lb.)
	Loaded, 9520 kg. (20,992 lb.)
Wing Loading:	29·7 kg./sq. m. (6·1 lb./sq. ft.)
Performance:	Maximum speed, 110 km.h. (68·4 m.p.h.)
	Climb, 2000 m. (6562 ft.) in 39 mins.
	Ceiling, 3000 m. (9843 ft.) in 79 mins.
Fuel:	1500 litres (330 Imp. Gals.)
Armament:	Provision for dorsal, ventral and nacelle machine-gun positions
Service Use:	Eastern Front with Kommando L.R.I. at Alt-Auz, August 1916

SPECIFICATIONS

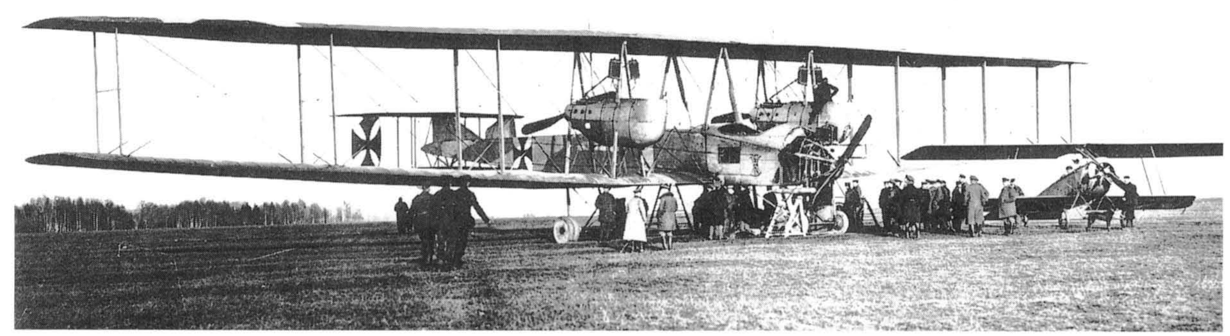
Type:	VGO.I (five-engined version)
Manufacturer:	Versuchsbau G.m.b.H., Gotha–Ost
Engines:	Four 245 h.p. Maybach Mb.IVa engines
	Two 160 h.p. Mercedes D.III engines
	or
	Five 245 h.p. Maybach Mb.IVa engines
Dimensions:	Span, 42·2 m. (138 ft. 5½ in.)
	Length, 24 m. (78 ft. 9 in.)
	Height, 6·6 m. (21 ft. 7½ in.)
Areas:	Wings, 320 sq. m. (3443 sq. ft.)
Weights:	Empty, 7450 kg. (16,427 lb.)
	Loaded, 11,485 kg. (25,325 lb.)
Wing Loading:	37·4 kg. sq. m. (7·7 lb./sq. ft.)
Performance:	Maximum speed, 130 km.h. (80·8 m.p.h.)
	Climb, 3000 m. (9843 ft.) in 60 mins.
Armament:	Provision for dorsal, ventral and two nacelle machine-gun positions
Service Use:	None

VGO.II

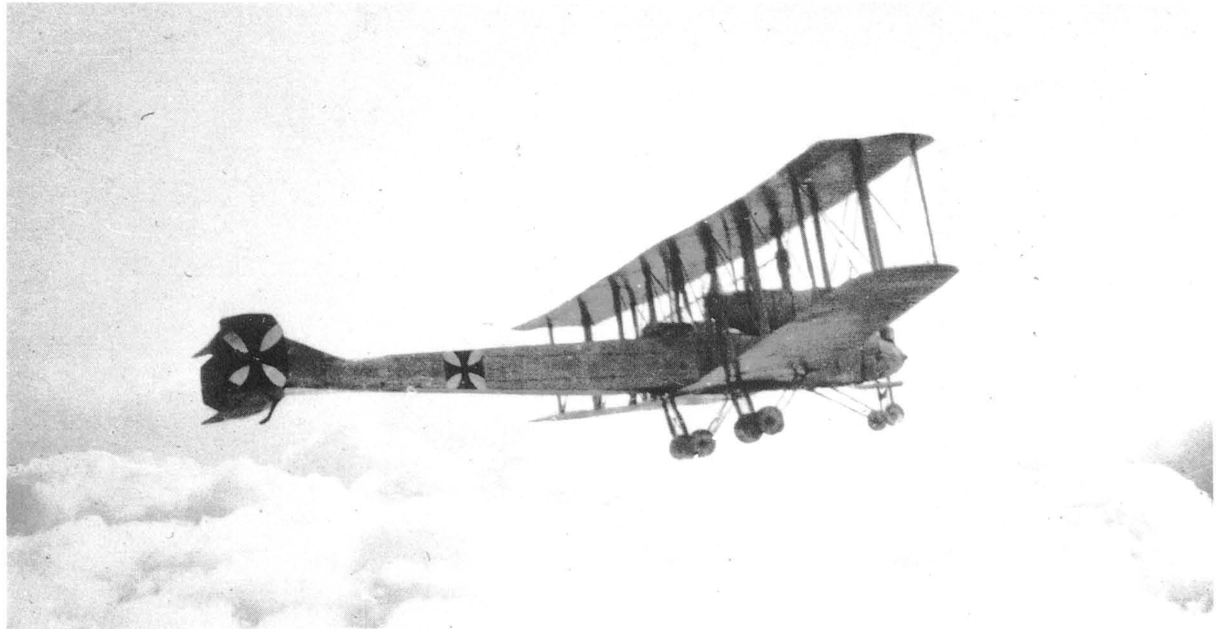
The VGO.II, first of a long line of Staaken giants accepted by the Army, was begun in December 1914 and its first flight was made in early September 1915. The flight characteristics were 'very satisfying' but radiator and engine problems caused appreciable delays. The VGO.II was accepted by Idflieg on 28 November 1915 and allocated the serial number R.9/15.

In construction and dimensions the airframe was virtually identical to the earlier VGO.I. However, in light of experience gained during test flights of the VGO.I, several modifications were made. In particular, the tail unit was redesigned; it retained the same biplane horizontal surfaces, but the gap was increased considerably. The number of vertical tail surfaces was reduced from four to two, but the rudders were given increased area, and the place of the inner rudders was taken by a pair of interplane struts. At a later date the fin area was increased by the addition of a large central fin. Another change was that the nacelles were fitted with a nose machine-gun position. The three 240 h.p. Maybach HS engines were cooled by H & Z radiators placed alongside the engines as in the prototype, with the exception that the fuselage radiators were of increased area. These were later replaced by block radiators mounted above the nacelles and fuselage nose. Additional machine-gun positions were located above and below the fuselage, one directly behind the rear cabane struts and the other farther aft level with the lower-wing trailing edge. This ventral position remained a standard feature on all later Staaken types.

In February 1916 the R.9 was delivered from Döberitz via Königsberg to Rfa 500 at Alt-Auz. The 900 km. distance was flown in 7½ hours in spite of snow flurries and low-hanging cloud cover, which forced the VGO.II to fly below 100 metres from Tilsit on. Offiziersstellvertreter (acting officer),



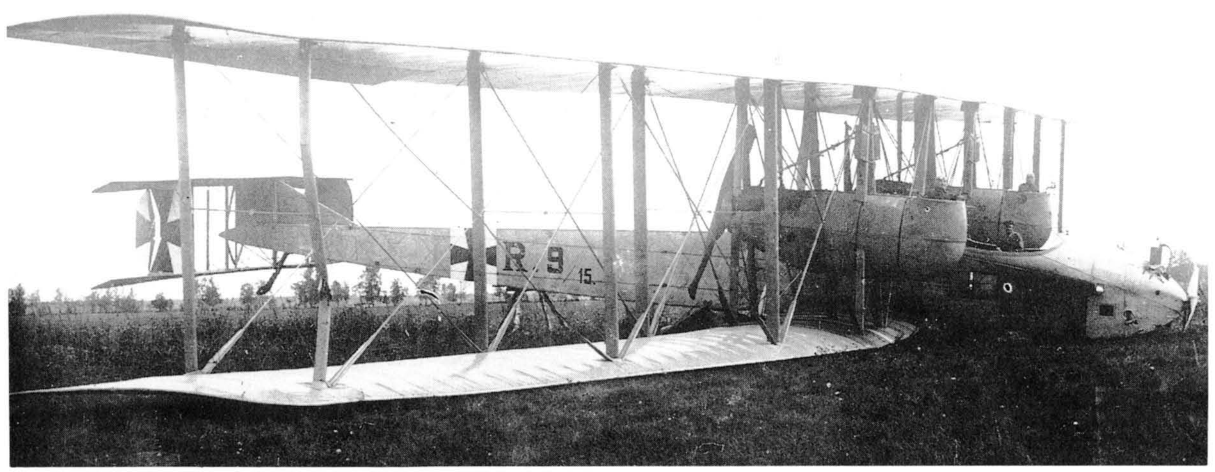
VGO.II 9/15. Photo probably taken at Döberitz prior to its service in the East.



The VGO.II 9/15. Photo dated 5 November 1915.

Selmer piloted the VGO.II on a number of operational test flights. While he claimed that the VGO.II dropped bombs on Russian targets as early as March 1916, no records have been found to back up his statement. It was not until five months later that the VGO.II was to receive credit for the first acknowledged successful R-plane bombing attack.

On 13 August 1916 the VGO.II took off from Alt-Auz, under the command of Oberleutnant Haller von Hallerstein, and successfully bombed the Russian rail junction at Schlok. The bomber was in the air for 3 hrs. 30 mins., carrying a useful load of 2296 kg. and reaching an altitude of 2500 metres. The VGO.II participated in a number of effective missions, such as the attack on the Russian railway station at Rodenpois in late autumn 1916. Having taken-off in the face of rapidly deteriorating weather, unexpected strong head winds were encountered on the return flight, and with 40 km. to go, the fuel ran out. The flight crew (Lt. Lühr, Lt. Frhr. von Buttlar and commander Lt. Max Schaefer) made a safe emergency landing on a small Fokker fighter field at Paulsgnade

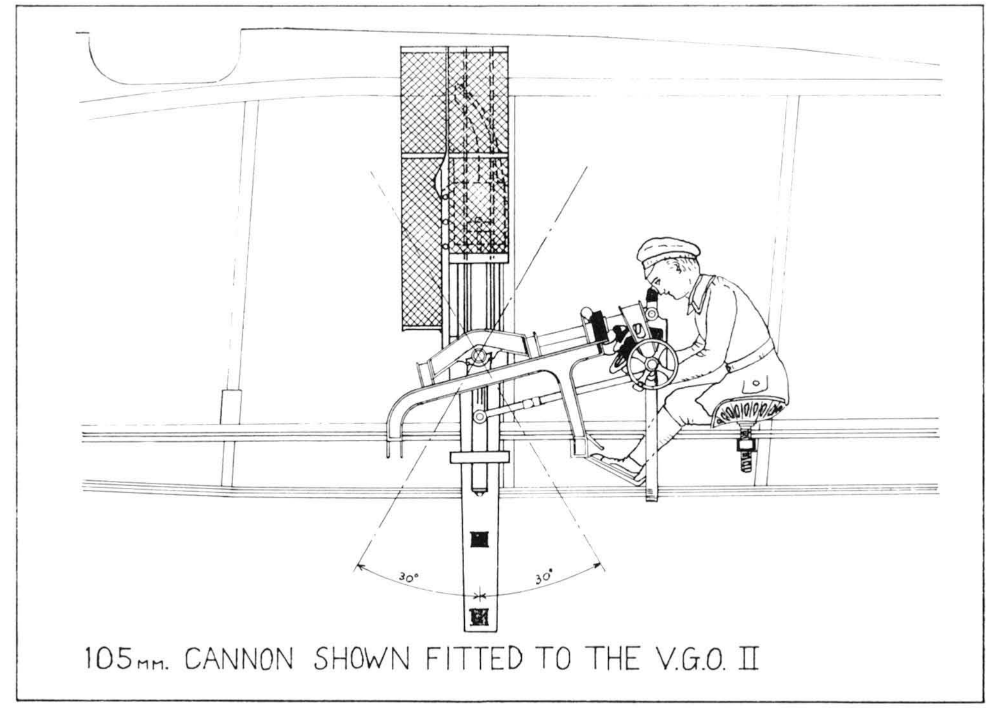


The emergency landing of the R.9 at Paulsgnade near Mitau.

near Mitau. Just short of coming to a stop, the VGO.II ran into a shallow ditch, which tore away the undercarriage, but with the exception of one broken strut, the aircraft was undamaged. Repairs were quickly made, and within a few days Vollmöller and Lühr flew the VGO.II back to Alt-Auz.

Lühr, who was also technical officer of Rfa 500, recalled an abortive attempt to place a machine-gunner in the tail of the VGO.II. On return from the sole test flight the hapless gunner was pulled out of the tail more dead than alive. Tail oscillations due to the flexibility of the fuselage structure (a common occurrence in the Staaken R-planes) had given the gunner a severe bout of air-sickness.

Another recollection of interest is that each time a downdraft was encountered the dangling Karbonit bombs, which were suspended vertically in the bomb bay, clanked together, making sounds like a "dancing skeleton", not to mention the adverse influence of the swinging mass of bombs on the flight characteristics.



Official drawing above shows installation of 105 mm. cannon, the gun actually mounted in the VGO.II was of 130 mm. calibre.

Among the more fascinating episodes in the development of R-planes was the installation of a downward-firing 13 cm. (5·13 in.) calibre cannon (called *Aussstossrohr* or launching tube) in the VGO.II. Leutnant Dr. Ernst Neuber of Fea 3 at Gotha reasoned that the higher the velocity of a downward-launched projectile, the shorter its flight duration, hence the better its accuracy and the greater its impact velocity. Neuber's report includes calculations on the feasibility of penetrating the deck armour of British battleships. On 10 February 1916 Neuber was authorized by the Prüfanstalt und Werft to proceed, and on 25 May a 12 kg. projectile was test fired from a 20 metre high tower into a 10 metre deep pit. A recoil force of 500–800 kg. was measured. Although VGO engineers were sure a 1500 kg. recoil force could be safely absorbed, the VGO.II structure was nevertheless reinforced. The cannon was mounted near the centre of gravity. Ground firing trials were performed on 6 and 10 October 1916 with varying powder charges. The recoil was only slightly noticeable, and in no way considered to be dangerous. After some small improvements and installation of a simple aiming device airborne firing tests were conducted on 19 October 1916. Again the much-feared recoil problem was found to be non-existent, the aircraft easily absorbing the recoil forces. Firing from a height of 800 metres, the shots missed the target by 40–45 metres, but this was blamed on

the inadequacy of the aiming device. The gun was returned to the factory for modification, and it is not known if further tests were conducted with the VGO.II; although a high-velocity 10·5 cm. calibre cannon was ordered on 7 November 1917. Neuber proposed a cannon-carrying, 2000 h.p. R-plane (see page 151) and obtained a patent, No. 305,039, for the gun-mounting system.

As the newer R-planes became available for service, the underpowered VGO.II was retired from operational service and relegated to training air crews at Döberitz. As a trainer, the VGO.II gave good service, and many of the crews that flew more powerful and improved giants later in the war must have had their first experience in this machine. In official records it was carried as a training machine attached to the Rea in Döberitz as of 1 January 1917. The following June it was under repair and it was fitted with a strengthened undercarriage. The end of the VGO.II came when it crashed and broke its back at Staaken, the exact date is unknown but it was probably in the summer of 1917. Photographs show that the machine did not catch fire, there are no reports of any officers being killed in the incident and the crew are believed to have escaped.

The final landing of the R.9 at Staaken, summer 1917. Note the raised tail surfaces.

In the spring of 1915 Austria-Hungary became interested in R-planes, and the greak Skoda works purchased a set of bomber plans, ostensibly of the VGO.I or VGO.II, from which an improved type was to be built. However, in spite of Austria-Hungary's thriving aircraft industry, no R-planes were ever constructed in that country.

Colour Scheme and Markings

The VGO.II was clear doped overall. The Patée cross on a white background was painted on the outer surfaces of the fins and rudders, fuselage sides, the top and underside of the upper wingtips and on the underside of the lower wingtips. At a later date the style of the Patée crosses was changed and the serial number R.9/15 painted in black on the sides of the fuselage.

SPECIFICATIONS

Type: VGO.II
Manufacturer: Versuchsbau G.m.b.H., Gotha-Ost
Engines: Three 240 h.p. Maybach HS (or Mb.IV) engines
Dimensions: Span, 42·2 m. (138 ft. 5¼ in.)
Chord inner, 4·6 m. (15 ft. 1 in.)
outer, 3·6 m. (11 ft. 10 in.)
Gap inner, 4·6 m. (15 ft. 1 in.)
outer, 3·6 m. (11 ft. 10 in.)
Incidence inner, 5½ degrees
outer, 2 degrees

Dimensions: Dihedral upper, none
lower, 3 degrees
Length, 23·78 m. (78 ft.)
Height, 7 m. (22 ft. 11½ in.)
Tailspan, 9 m. (29 ft. 6 in.)
Wheel diameter, 1·02 m. (3 ft. 4 in.)
Propeller diameter, 3·88 m. (12 ft. 9 in.)
Areas: Wings, 332 sq. m. (3572 sq. ft.)
Weights: Wings, 2,070 kg.
Tail unit, 365 kg.
Fuselage, 1,270 kg.
Accessories, 140 kg.
Undercarriage, 793 kg.
Engines, 1,999 kg.

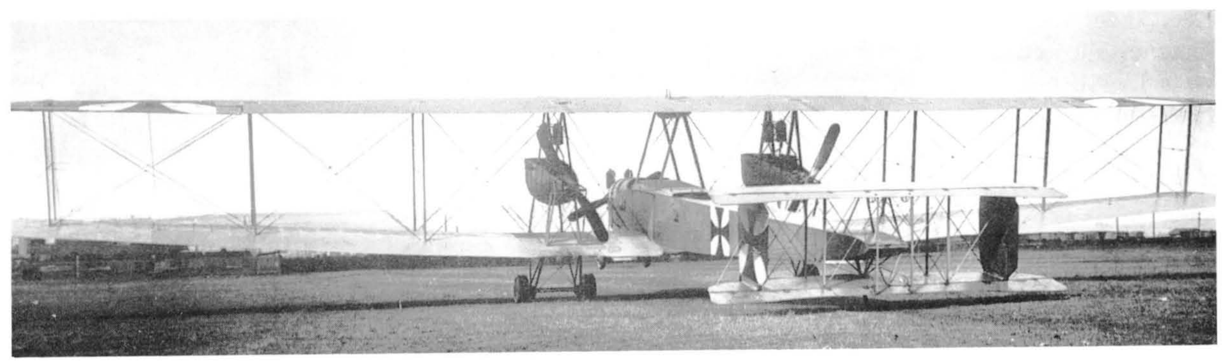
Empty, 6,637 kg. (14,635 lb.)
Fuel, 1,126 kg. (2,483 lb.)
Disposable load, 2,440 kg. (5,380 lb.)

Loaded, 10,203 kg. (22,498 lb.)
Wing Loading: 30·7 kg./sq. m. (6·3 lb./sq. ft.)
Performance: Similar to VGO.I
Fuel: Tank 1, 1120 litres (247 Imp. Gals.)
Tank 2, 668 litres (147 Imp. Gals.)
Gravity tank, 24 litres (5·3 Imp. Gals.)
Oil engines, 36 litres (7·9 Imp. Gals.)
Oil tank, 102 litres (22·4 Imp. Gals.)
Armament: Provision for dorsal, ventral and two nacelle machine-gun positions
Service Use: Eastern Front with Rfa 500 at Alt-Auz 1916. Training machine at Döberitz 1916–17
Cost: The German Government paid 360,000 marks for the VGO.II. Construction cost was 401,000 marks, and engines cost 75,000 marks.

VGO.III

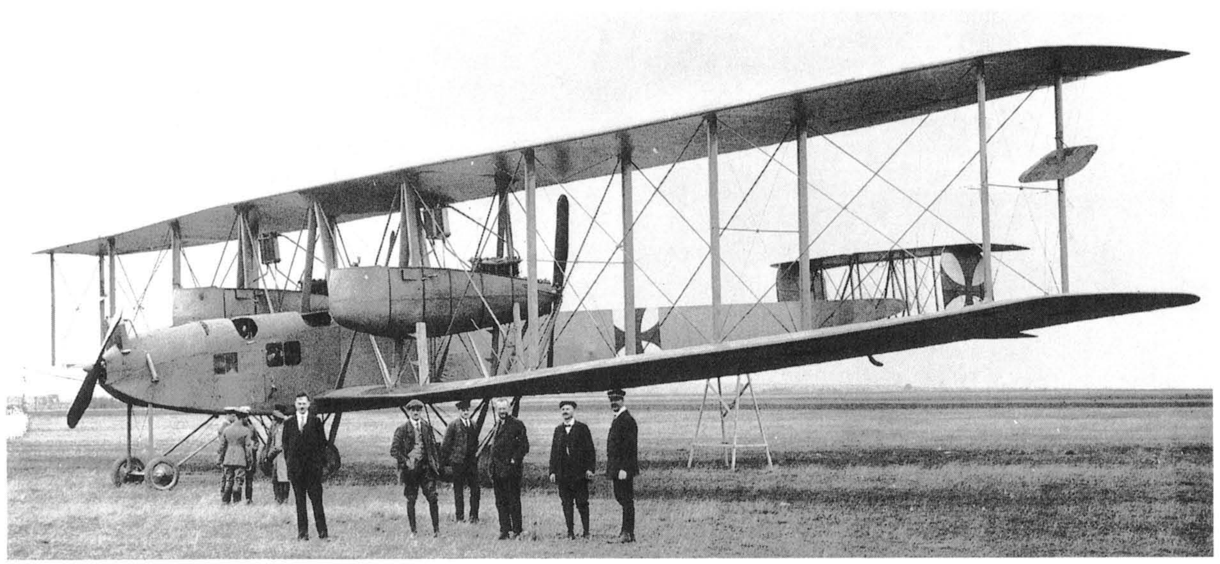
During October 1915 construction of the third Staaken giant, the VGO.III, was begun at Gotha. Early in the design stage it was decided to find alternative engines for the experimental 240 h.p. Maybach HS engines, which had proven to be unreliable for extended flights. In their place, the thoroughly-tested 160 h.p. Mercedes D.III engine was chosen, and to compensate for their lower output, six engines were used, increasing the total horse-power of the VGO.III to 960 h.p. as compared to the 720 h.p. available to the first two VGO types.

The method of installation was entirely new. Two engines were mounted side by side in the



VGO.III 10/15.

fuselage nose and their crankshafts faced a central gear-box at an angle of about 8 degrees. Two large clutches were fitted to the front of each engine. A short extension shaft coupled each engine to the gear-box, which in turn drove a large tractor propeller. This method of coupling two engines to a common gear-box proved fairly successful as long as the engine crews were well trained and low-powered engines were used. Even so, this system was not entirely free of faults. The drive assembly produced a great deal of noise, particularly at certain engine speeds when fuselage, gears, extension shaft and propellers all began to resonate in unison. In fact, it was possible to see the standing waves in the extension shaft change as the engine speed was varied. In one instance the extension shaft broke in flight, and it required some four to six weeks to repair the damage. Later attempts to couple higher-powered engines to a common gear-box proved generally unsuccessful (see VGO.I and Staaken R.VII). Two large block radiators were mounted above the nose directly behind the propeller. The engines could be serviced in flight by a mechanic stationed in the large engine compartment, but from all accounts the ear-splitting noise made his life virtually impossible. Access was provided by a door on the port side, through which other crew members could also enter. The compartment was fitted with windows and sliding hatches to adjust interior ventilation, as well as a large open cockpit for the engine crew.

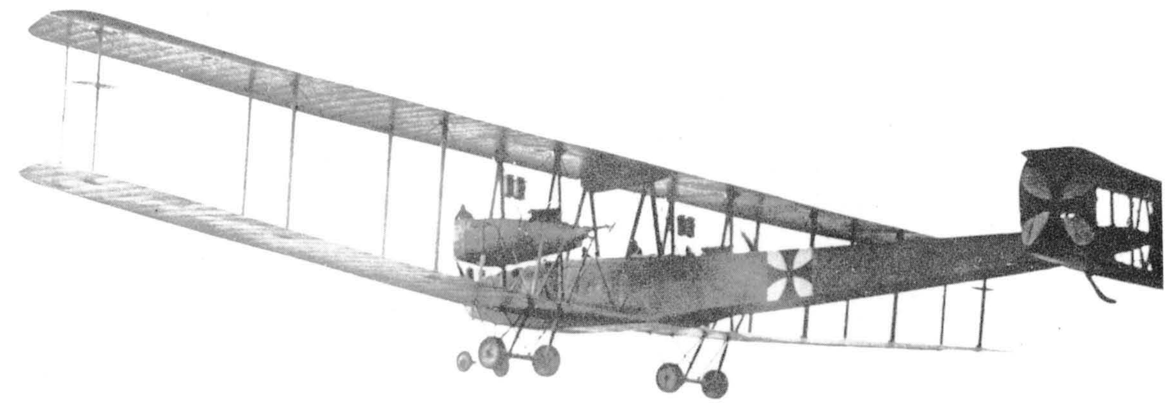


The VGO.III shown fitted with aileron balancing surfaces attached to the rear struts. From left to right: Hans Baumeister, Anton Diemer, Foreman Ridlein, Gustav Klein, Grimmeisen and Boenisch.

The remaining engines were mounted in tandem pairs in the outboard nacelles and drove pusher propellers. The leading engine was mounted lower in the nacelle, allowing a transmission shaft to pass under the rear engine; both drive shafts terminated in a common gear-box. The individual clutches allowed the engines to be started singly and run independently of each other. The nacelles were lengthened considerably to accommodate the additional length of the engine–gear-box combination. To support the overhanging weight of these components an extra pair of struts was added at the rear of the nacelle. A pair of block radiators were mounted side by side between the nacelle and upper wing just behind the forward struts.

As in the VGO.II, the nacelle engines were serviced by a gunner-mechanic who occupied the gun position in the front of each nacelle. Other machine-guns were located in dorsal and ventral fuselage positions behind the wings. Several tests were performed to investigate the feasibility of firing a 2 cm. cannon from the dorsal gun position; however, machine-guns remained the standard armament.

The wing was identical to those used on the earlier machines, with the addition of a long gravity tank fitted at the junction of the centre-section struts. During flight testing an unusual system of

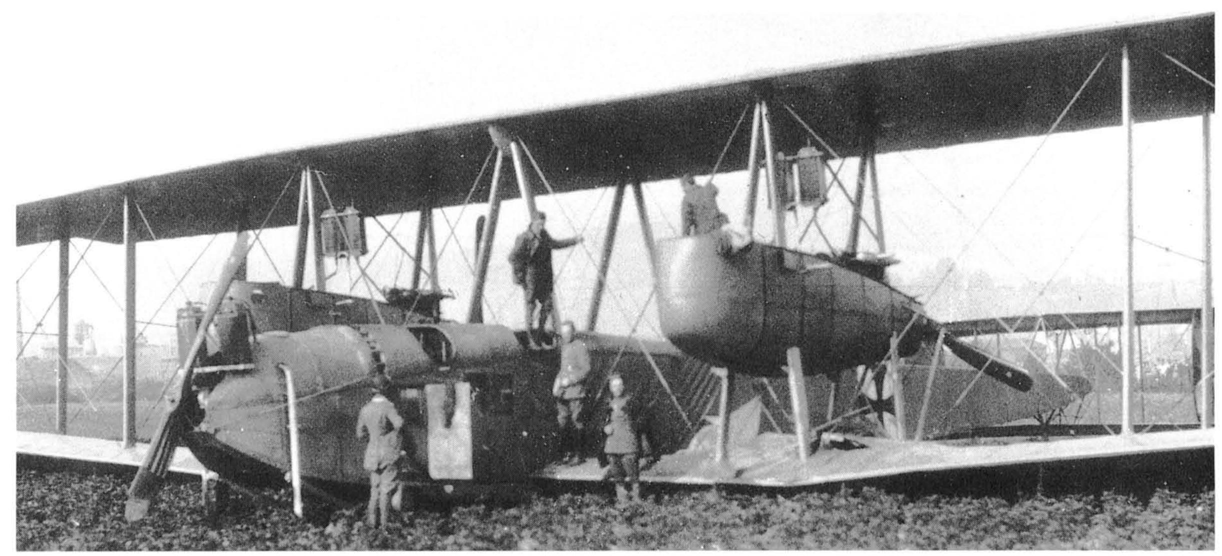


VGO.III 10/15 taking.off from Gotha to fly to Döberitz, August 1916.

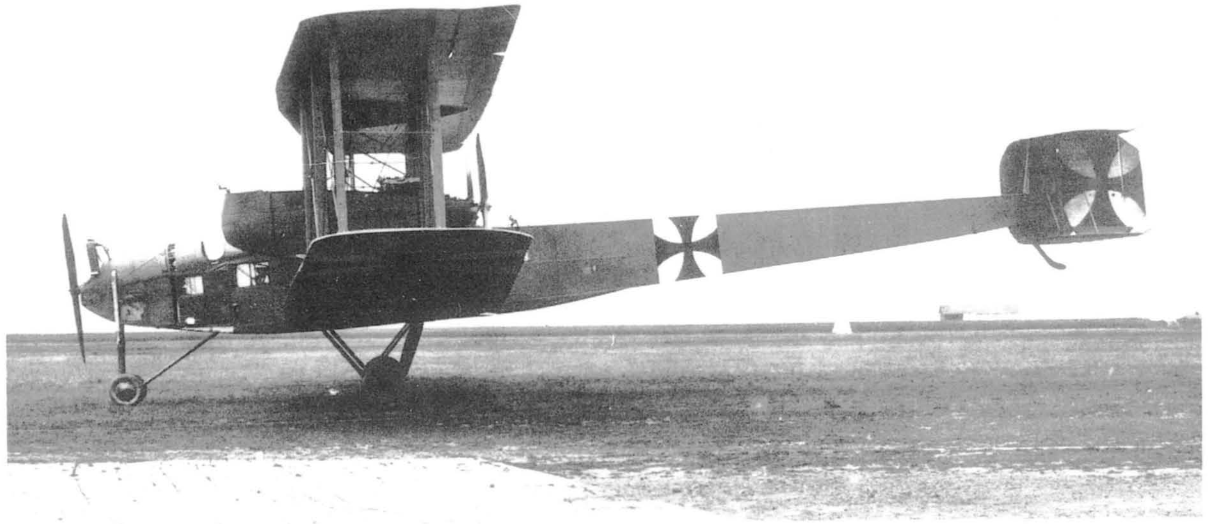
aileron balance was tested. Small auxiliary surfaces were hinged two-thirds up the rear outer interplane strut. About three-quarters of this surface was in front of its hinge point. This experimental aileron compensator was connected to the main aileron cables in such a way that it would aerodynamically lighten the loads on the control cables. Although this primitive method of aileron "balancing" was used on a number of contemporary Gotha and Brandenburg seaplanes, it did not find favour on the VGO.III, as it was later removed and not used again on other Staaken machines.

Aside from the addition of the flight-engineer's compartment in the nose and the relocation of the pilot's cockpit farther aft, the VGO.III fuselage was similar to the VGO.II. All tail control cables were housed internally, emerging from the fuselage about 6 feet from the tail. This became a standard practice on all future Staaken R-planes. The tail unit was similar to the VGO.II, with the exception of slightly increased fin area.

The aircraft was allocated serial number R.10/15. The exact date of the first flight is unknown, but it occurred between 29 May and 4 June 1916. On 13 June 1916 it flew from Gotha to Friedrichshafen (to have the Zahnradfabrik G.m.b.H. run tests with the propeller reduction gearing) landing at Sindel fingen (location of the Daimler airfield) on the way. The VGO.III was



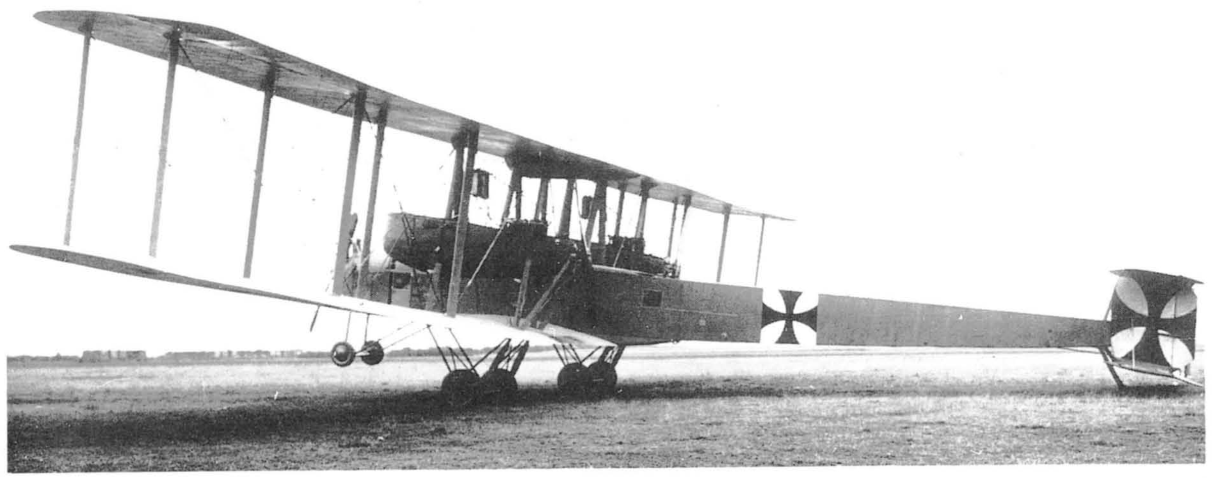
Only minor damage was sustained by VGO.III during a forced landing, date unknown.



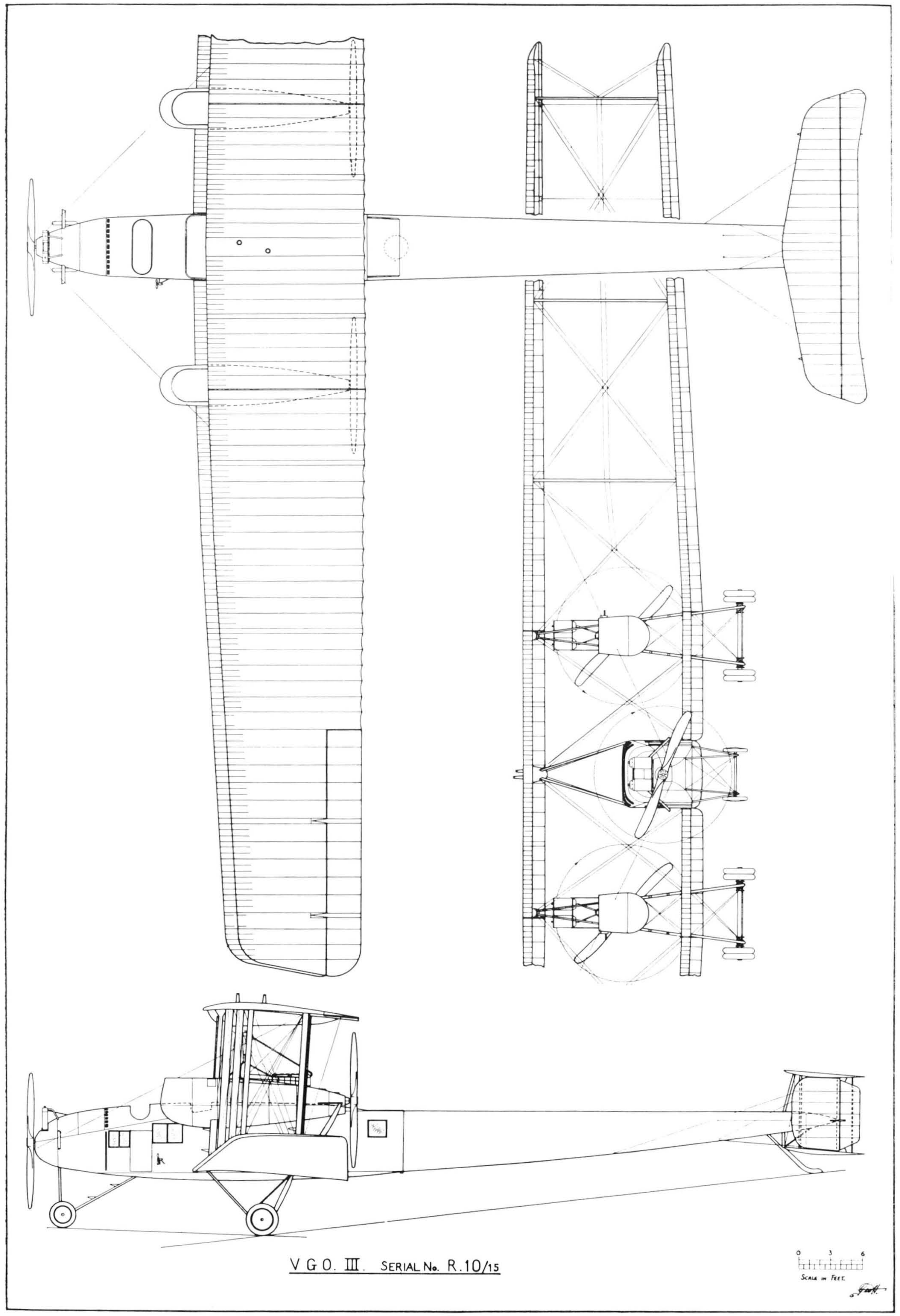
VGO.III 10/15

accepted by Idflieg (Rea) on 28 August 1916 and delivered to Rfa 500 on 8 September. Offstv. Selmer, who also piloted the VGO.III, stated that the bomb installation was improved over earlier types, in that the bombs were hung beside each other rather than over one another and were released electrically. The crew consisted of seven men, including one wireless operator who worked the only type of wireless set fitted to R-planes at the time: a Siemens-Schuckert transmitter initially built for Austrian bombing planes and a Telefunken receiver. Power was supplied by an AEG generator driven by a small 2-cylinder Bosch petrol engine. Attempts to drive the generator by coupling it directly to the engines or by a small slipstream-mounted propeller were unsuccessful.

The VGO.III completed about seven bombing missions, during which its targets were railway installations, troop encampments and depots in the vicinity of Riga. On a 3 hr. 10 min. bombing



The VGO.III is here shown resting on its tailskid; the more normal attitude was for it to rest on its nose wheels with the tail high.



mission on 22 September 1916, it carried a useful load of 3310 kg. and reached an altitude of 3000 metres.

On 24 January 1917 the first fatal R-plane accident occurred when the VGO.III, returning from a training mission, came in to land at Alt-Auz. With Selmer at the controls, the VGO.III was forced to touch-down prematurely due to a sudden downdraft. The ground was soft and covered with snow, and after some 10 metres the front wheels struck a hidden obstruction and snapped off. The sudden braking action caused the main undercarriage to collapse, the fuselage to break in two and the lower wings to tear off. The ruptured fuel lines sprayed petrol over the nose exhaust stacks, and the VGO.III was completely destroyed by fire, with loss of five crew members. A survivor stated that the forward fuel tank had burst on impact and had filled the fuselage with petrol. At an inquiry into the causes of the accident it was concluded that the nose undercarriage struts were too robust. Had they broken away sooner on striking the obstruction, the crash might not have been so serious. On later Staaken types the nose undercarriage or "*Stossfahrgestell*" was considerably shortened and possibly reduced in strength.

Colour Scheme and Markings

The VGO.III was clear doped overall, giving it a cream-buff colour. The cross Patée on white squares was carried on the fuselage sides and on all four wingtips. The outer fin and rudder surfaces were painted all white, and the cross Patée was the largest possible for the area available. No other markings were visible.

SPECIFICATIONS

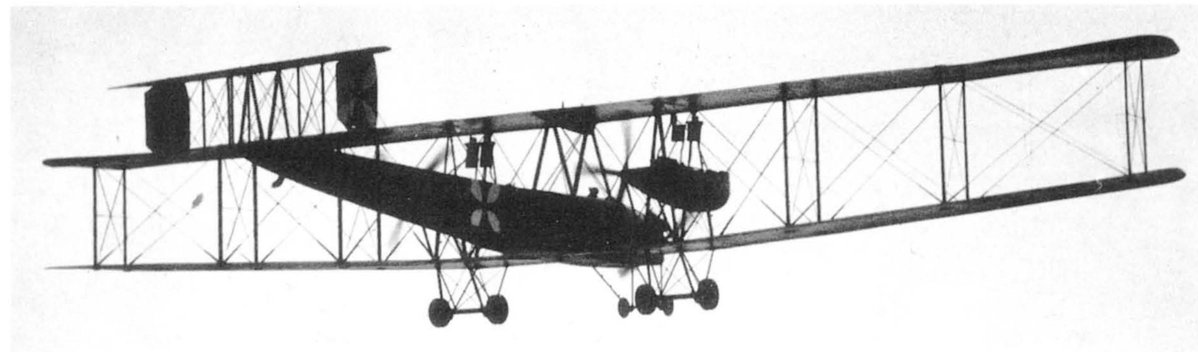
Type:	VGO.III
Manufacturer:	Versuchsbau G.m.b.H., Gotha-Ost
Engines:	Six 160 h.p. Mercedes D.III engines
Dimensions:	Span, 42·2 m. (138 ft. 5½ in.)
	Length, 24·5 m. (80 ft. 4½ in.)
	Height, 6·8 m. (22 ft. 3½ in.)
Areas:	Wings, 332 sq. m. (3572 sq. ft.)
Weights:	Empty, 8600 kg. (18,963 lb.)
	Loaded, 11,600 kg. (25,578 lb.)
	Bomb load, 400–800 kg. (882–1764 lb.)
Performance:	Maximum speed, 120 km.h. (75 m.p.h.)
	Climb, 1000 m. (3281 ft.) in 16 mins.
	2000 m. (6562 ft.) in 29 mins.
	3000 m. (9843 ft.) in 56 mins.
	Ceiling, 3000 m. (9843 ft.)
	Duration, 6 hours
Fuel:	3500 litres (770 Imp. Gals.)
Armament:	Provision for two dorsal, one ventral and two nacelle machine-gun positions
Service Use:	Eastern Front with Rfa 500 at Alt-Auz, September 1916–January 1917

Staaken R.IV

With the growth of Allied air power, the possibility of an air strike against the Zeppelin airship works at Manzell became increasingly threatening. To forestall a possible crippling blow to the German airship programme, Major Thomsen urged the Zeppelin concern to establish a subsidiary airship works in a safer location, which it did in early 1916 at Staaken near Berlin. On 1 August 1916 the VGO works was officially transferred from Gotha to Staaken and renamed Flugzeugwerft G.m.b.H. The move was a natural outcome of the growth of the industry. Staaken would offer better facilities for the expansion of Zeppelin R-plane production and release space for Gotha Waggonfabrik. On 15 June 1916, the first group of VGO personnel began the transfer to Berlin

(Staaken). With the reduction of airship construction in 1917 and its stoppage in January 1918, the Flugzeugwerft G.m.b.H. was easily able to absorb the airship workers and hangar space.

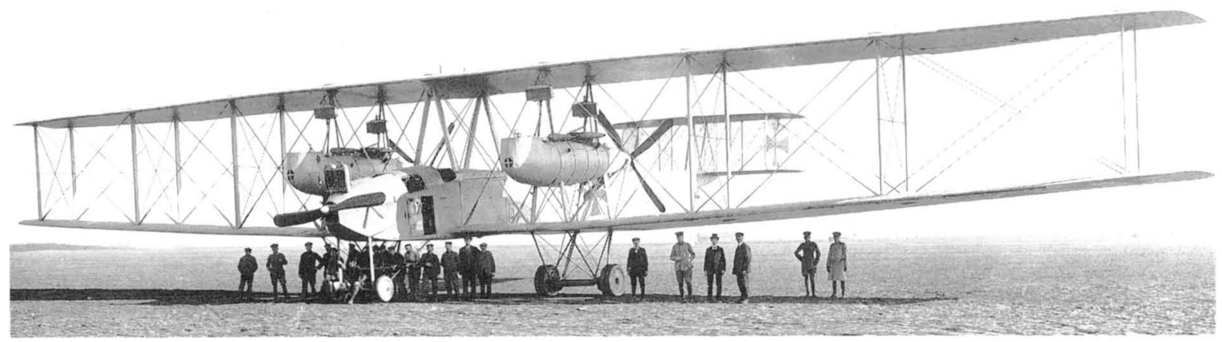
A contemporary report states that the fourth VGO R-plane was in its first stages of construction at Gotha in February 1916. The machine completed its maiden flight on 16 August 1916, and by



The form in which the Staaken R.IV 12/15 first flew.

the time it had finished its flight tests the transfer of VGO to Staaken had taken place. Consequently, on being delivered to the Army this machine was the first of the Zeppelin-built giants to be officially designated a Staaken type, and under the Idflieg numbering system was known as the Staaken R.IV 12/15.

The general layout of the Staaken R.IV followed closely that of its predecessor, the VGO.III. There was no change in the installation of the two 160 h.p. Mercedes D.III engines in the nose. The only visible differences were the close spacing of the two radiators and the exhaust stacks fitted into channels in the upper fuselage panelling. This in contrast to the VGO.III, where the stacks were housed internally and emerged at a sharp angle from the side panels.



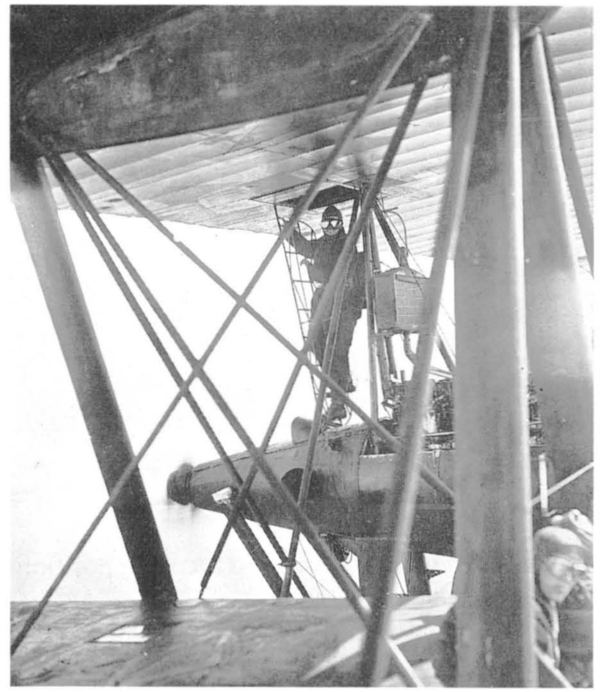
The Staaken R.IV prior to the fitting of upper wing armament.

The desirability for more power and the availability of the new 220 h.p. Benz Bz.IV engines led to their installation as tandem pusher units in the nacelles. The additional 240 h.p. over the VGO.III gave the Staaken R.IV a total of 1200 h.p. and made it the first of the more powerful second generation Staaken R-planes. The engine coupling in the R.IV proved very successful, primarily for the reason that exceedingly well-trained engine crews had been assigned to this machine, making a thorough test programme possible. In fact, the R.IV was the only R-plane with coupled engines to see service on both the Eastern and Western fronts up to the very end of the war. A remarkable showing, considering the difficulties experienced by other Staaken R-planes fitted with coupled engines.

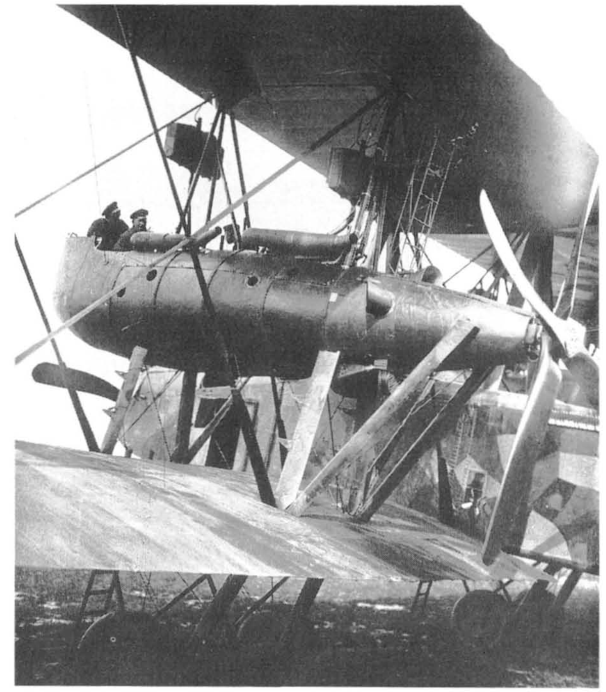
Dorsal gunner's position on the Staaken R.IV.

Forward engineer compartment of the Staaken R.IV.

The nacelle engines were arranged in the same way as in the VGO.III, but it was necessary once again to lengthen the nacelles to accommodate the new gear-box, Mercedes-built clutch and larger engines. Zahnradfabrik G.m.b.H., a Zeppelin subsidiary, built the gear-box, which reduced the 1400 r.p.m. of the engines to 860 r.p.m. for the propellers. The Garuda four-bladed propellers rotated in opposite directions and were placed well clear of the trailing edges. Initially the nacelle radiators were mounted in the manner of the VGO.III, but as these did not provide sufficient cooling, they were replaced by larger radiators mounted on front and rear nacelle struts; the front radiator was higher than the rear to avoid blanketing the rear radiator.



Member of the crew of the Staaken R.IV ascending to the upper wing gun platform.



Mechanics working in the port engine nacelle of the Staaken R.IV 12/15.

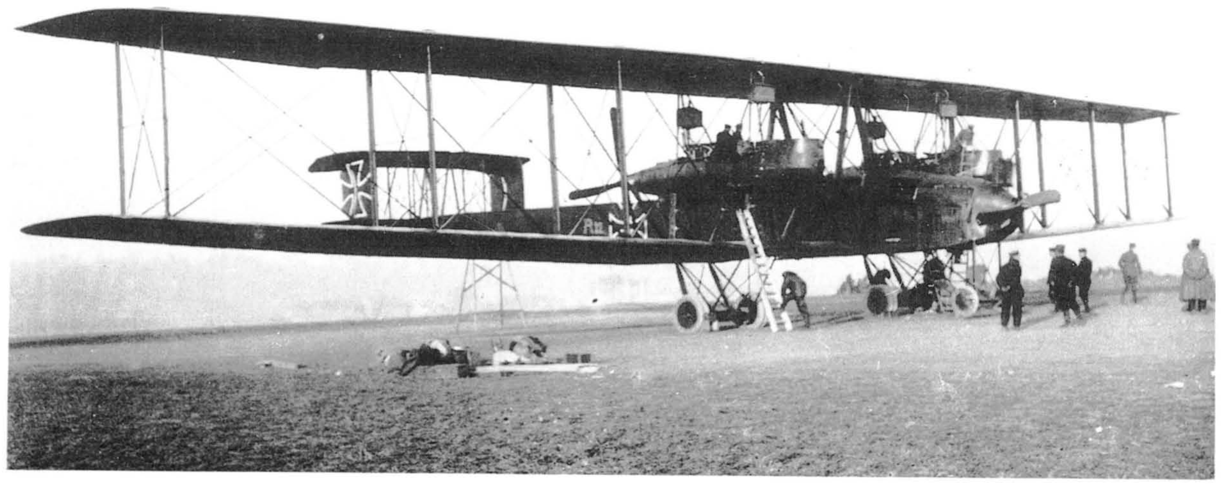
The same wing structure was employed, differing only in the reduction of lower wing dihedral from 3 to 1½ degrees.

The fuselage was shortened slightly ahead of the wings; the open engineer's cockpit was replaced by a square hatch with sliding covers and the ventral machine-gun position was lowered to improve the field of fire. The resultant fairing produced a noticeable bulge under the fuselage.

Although the tail remained structurally the same, it was raised to a position above the fuselage to prevent damage to the tail surfaces when landing on the tail skid. The lower tail spars ran under the top fuselage longeron, a feature retained on succeeding types.

With the exception of landing lights attached to the auxiliary struts, the design of the undercarriage remained unchanged.

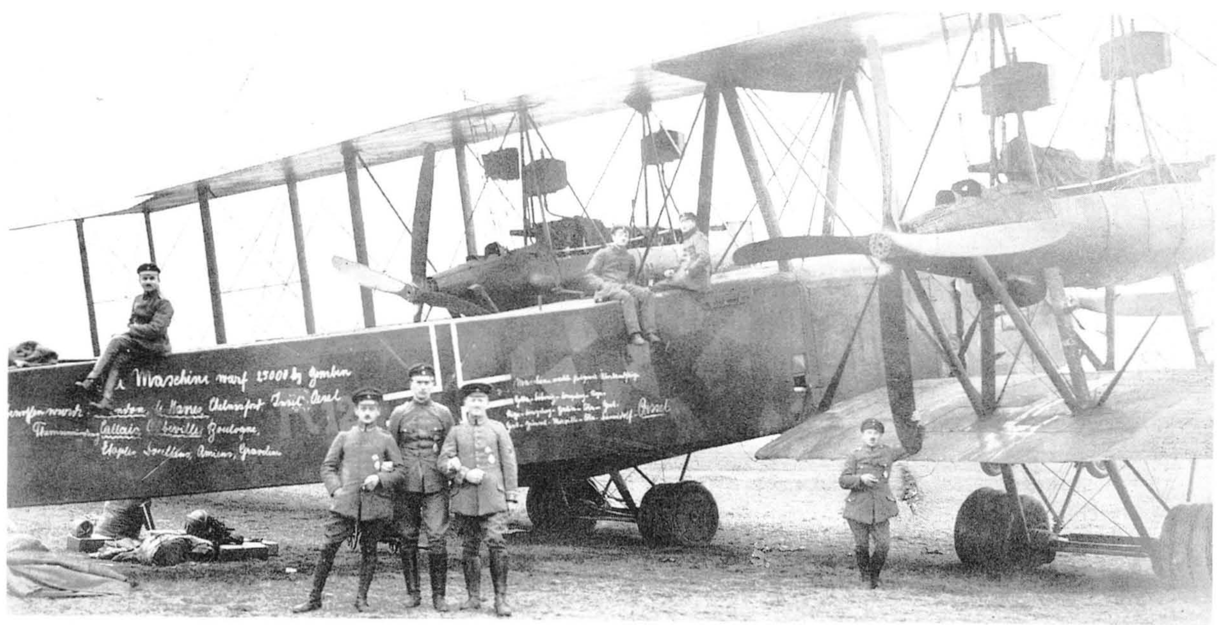
A great deal of thought was given to the defensive armament of the R.IV. Soon after initial flight tests, machine-gun positions were built into the upper wings directly above the nacelles and behind the rear wing spar. Counting the two dorsal, one ventral and two forward nacelle gun positions, a formidable armament of seven machine-guns could be carried; a considerable number for one aircraft at that time. The wing position was reached by climbing a ladder leading from the nacelle to a platform hinged to the rear nacelle struts. The platform could be folded to allow the gunner to climb up and down, and sliding panels above and below the wing enclosed the position when not in use. The ladder was completely exposed and only a few feet from the propellers, so that the journey



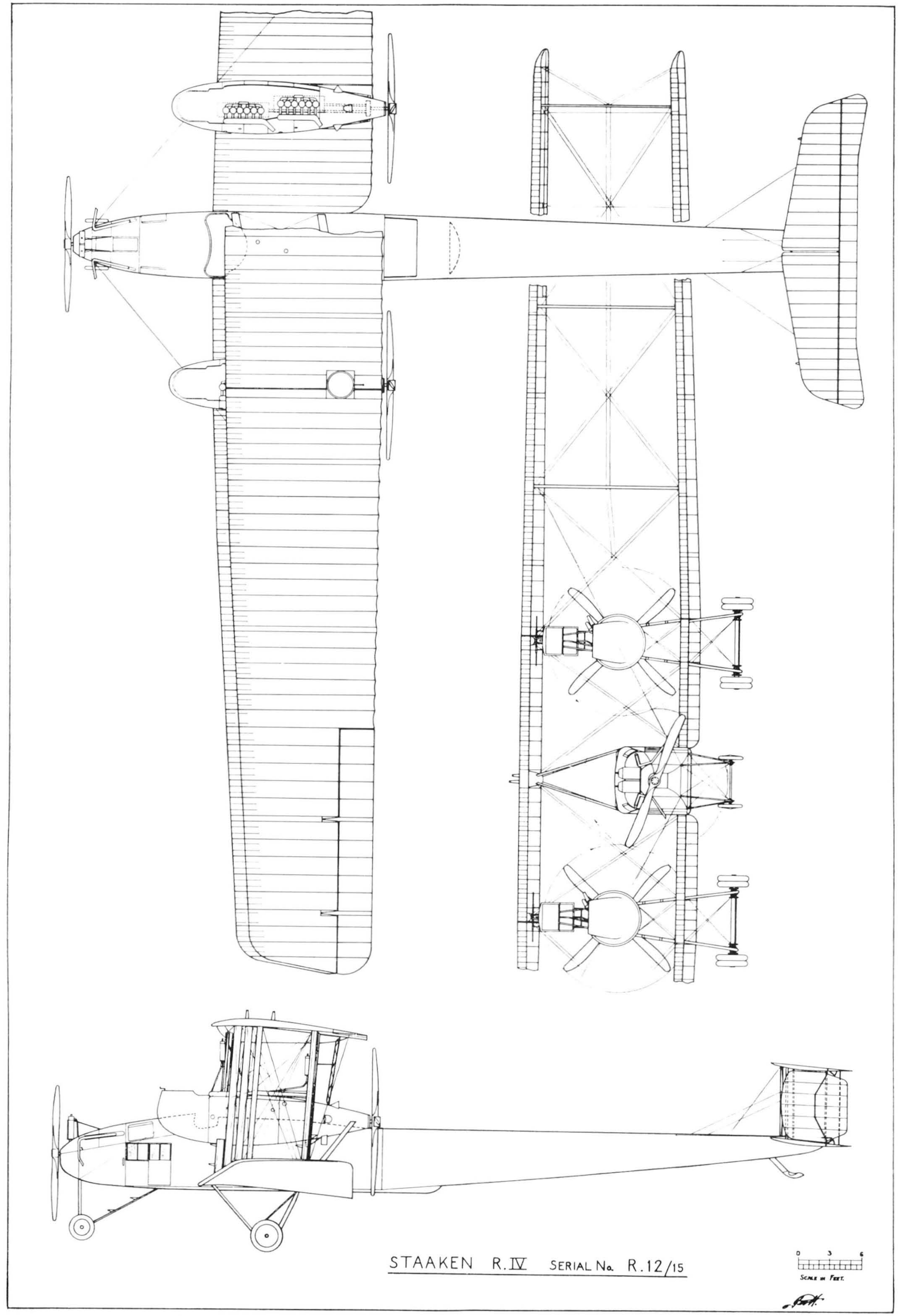
Staaken R.IV 12/15 in night camouflage on the Scheldewindeke airfield.

to the gun position must have been both exciting and hazardous. Idflieg considered the wing position useful, for they continued to be installed in several of the later Staaken types.

After flight tests and modifications were successfully completed the R.IV was accepted by the



The Staaken R.IV and its crew at Kassel after the war. The targets attacked, the total weight of bombs dropped and places flown to have been chalked on the fuselage side.



Army Air Services on 5 May 1917 to begin an operational service life longer than any other R-plane. On 12 June 1917, the R.IV was flown to Alt-Auz from Gotha via Döberitz and Königsberg to join Rfa 500. The flight went smoothly in every respect. On the Eastern Front the R.IV participated in raids on Wolmar (28/29 June 1917), Oesel (8/9 July 1917) and possibly other Russian targets. A contemporary report describes the transfer of the R.IV to the Western Front.

> On the flight from Alt-Auz to Metz the stages Alt-Auz–Königsberg and Königsberg–Döberitz were completed without mishap. The fact that both stages were flown at night, without specific orders to do so, is proof of the crew's confidence in the aircraft. The landing in Königsberg on 18 July 1917, performed in ground fog, went smoothly.

Assigned to Rfa 501 stationed in the Ghent district, the R.IV listed London, Chelmsford, Thames Estuary, Calais, Morville, Boulogne, Etaples, le Havre, Gravelines, Deauville and Doullens as its targets in its long and varied career on the Western Front, during which a total of 25,000 kg. bombs were dropped. It also survived a collision with the balloon apron guarding London (see Operational chapter for details). After the war the R.IV, presumably *en route* to Liegnitz to be broken up, was, in April 1919, shown to awed crowds at Kassel and other German cities.

Colour Scheme and Markings

In its first form the R.IV was clear doped overall and carried national markings of the same style and pattern as the VGO.III. Later, with the installation of the wing gun positions, it was either re-covered in printed fabric with the standard irregular polygon design, or the design was painted over the old fabric. The Patée crosses were outlined in white on the camouflage pattern, but by mid-1918 these had been changed for the Latin cross with narrow white outlines. These crosses occupied the full chord of the wings, the depth of the fuselage sides and the entire area of the fins and rudders.

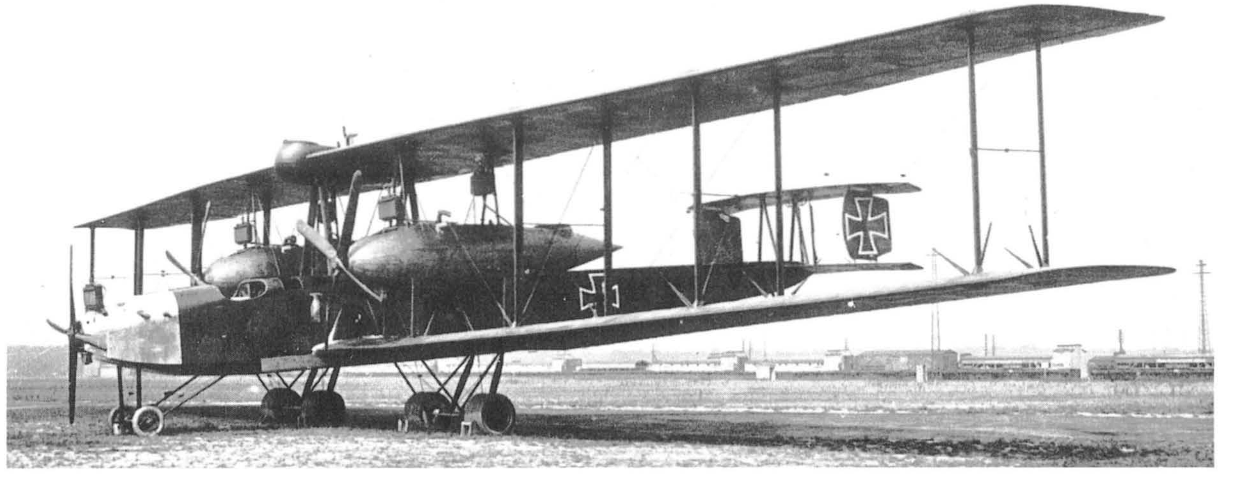
SPECIFICATIONS

Type:	Staaken R.IV	
Manufacturer:	Flugzeugwerft G.m.b.H., Staaken, Berlin	
Engines:	Two 160 h.p. Mercedes D.III engines	
	Four 220 h.p. Benz Bz.IV engines	
Dimensions:	Span, 42·2 m. (138 ft. 5½ in.)	
	Chord inner, 4·6 m. (15 ft. 1 in.)	
	Chord outer, 3·6 m. (11 ft. 10 in.)	
	Incidence inner, 3½ degrees	
	Incidence outer, 2 degrees	
	Dihedral upper, None	
	Dihedral lower, 1½ degrees	
	Length, 23·2 m. (76 ft. 1 in.)	
	Height, 6·8 m. (22 ft. 3½ in.)	
	Tail span, 9 m. (29 ft. 6 in.)	
	Wheel diameter, 1·02 m. (3 ft. 4 in.)	
	Tractor propeller diameter, 4·2 m. (13 ft. 9 in.)	
	Pusher propeller diameter, 4·3 m. (14 ft. 1 in.)	
Areas:	Wings, 332 sq. m. (3572 sq. ft.)	
Weights:	Wings,	2,350 kg.
	Fuselage,	1,450 kg.
	Tail unit,	400 kg.
	Undercarriage,	900 kg.
	Accessories,	123 kg.
	Engines and transmission,	3,549 kg.
	Empty,	8,772 kg. (19,342 lb.)
	Fuel,	2,140 kg. (4,719 lb.)
	Disposable load,	2,123 kg. (4,681 lb.)
	Loaded,	13,035 kg. (28,742 lb.)

Wing Loading:	39·2 kg./sq. m. (8·0 lb./sq. ft.)
Performance:	Maximum speed, 125 km.h. (77·5 m.p.h.)
	Climb, 1000 m. (3281 ft.) in 10 mins.
	2000 m. (6562 ft.) in 35 mins.
	3000 m. (9843 ft.) in 89 mins.
	Ceiling, 3700 m. (12,139 ft.)
	Duration, 6–7 hrs.
Fuel:	2080 litres (458 Imp. Gals.)
	Oil engines, 53 litres (11·7 Imp. Gals.)
	Oil tank, 130 litres (28·6 Imp. Gals.
Armament:	Provision for six to seven machine-gun positions.
Service Use:	Eastern Front with Rfa 500 at Alt-Auz, June 1917 to July 1917. Western Front with Rfa 501 in Ghent area July 1917 to November 1918.

Staaken R.V

The Staaken R.V was another step in a series of experiments to develop the correct formula for the decentralized-engined Staaken giants. Whereas the previous Staaken types represented a combination of tractor and pusher propulsion, the R.V had all its engines driving tractor airscrews. This configuration was chosen to provide a powerful and free field of fire to the rear. The R.V, with its five Maybach engines, was the most powerful German R-plane until the advent of the Benz-powered Aviatik licence-built Staaken R.XVI.



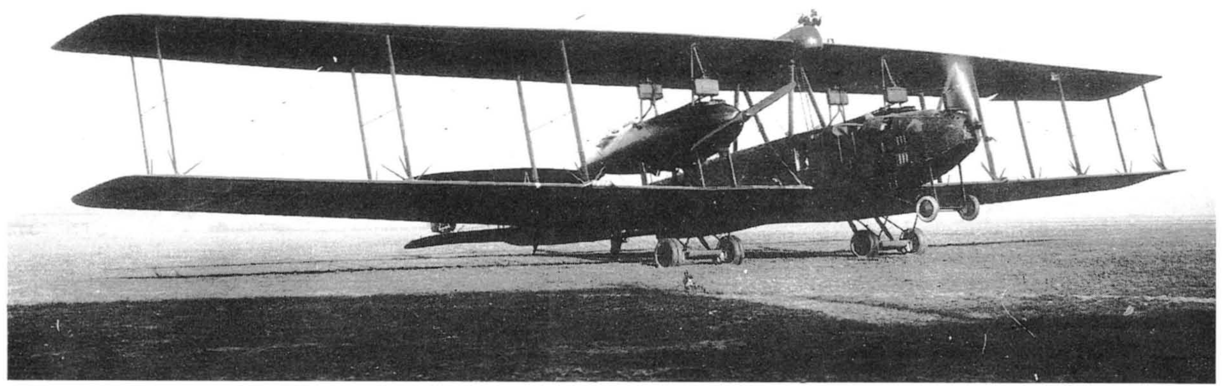
Staaken R.V 13/15.

The engine layout could best be described as the Staaken R.IV system in reverse. Two engines in each nacelle were coupled to a common gear-box which drove a four-bladed Garuda tractor airscrew. The rear engine was stepped down to allow its transmission shaft to pass under the forward engine. Viewed from above, each engine was offset slightly from the nacelle centre line. In contrast to the R.IV, the similar transmission system of the R.V proved troublesome. The technical problems required a long time to solve, and many minor changes were made before the necessary reliability was attained. The more powerful 245 h.p. high-compression Maybach Mb.IVa engines gave rise to greater transmission forces, as compared to the lower-powered engines of the R.IV, and this is where the trouble lay. As a result, the R.V, which was begun in June 1916, was not accepted until 29 September 1917, some three months after the Staaken R.VII 14/15 and Staaken R.VI 25/16.

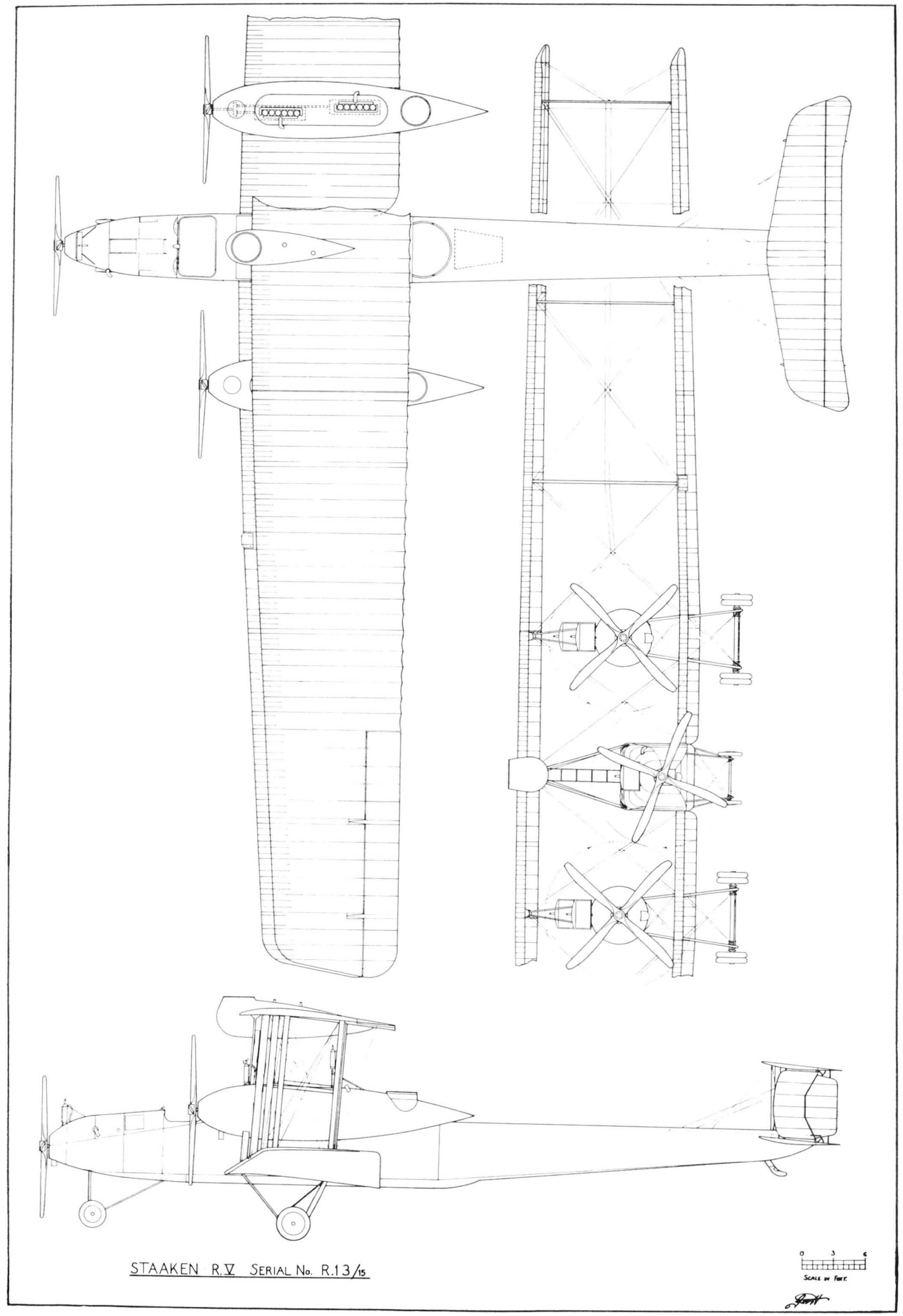
Staaken R.V 13/15, fitted with two-bladed propeller at the nose.

The basic airframe followed closely the configuration of the previous Staaken machines, with few exceptions. The streamlined engine nacelles were a departure, for they were built of a wooden framework covered with plywood. This monocoque construction helped reinforce the engine mounts to the extent that vibrations and oscillations were greatly reduced. The engines were easily accessible, because internal bracing and cable work was eliminated. The streamline form was aerodynamically desirable but time-consuming and expensive to fabricate, precluding its use on succeeding Staaken aircraft. The nacelle underside remained open to allow fuel and vapours to escape. The tail of each nacelle extended well beyond the trailing edges of the wing, and each was equipped with a machine-gun ring that was to be manned by the flight mechanics.

The single, geared Maybach engine in the nose was cowled by aluminium panels in a manner similar to the R.IV and R.VII machines. The Maybach engines required five large radiators; one



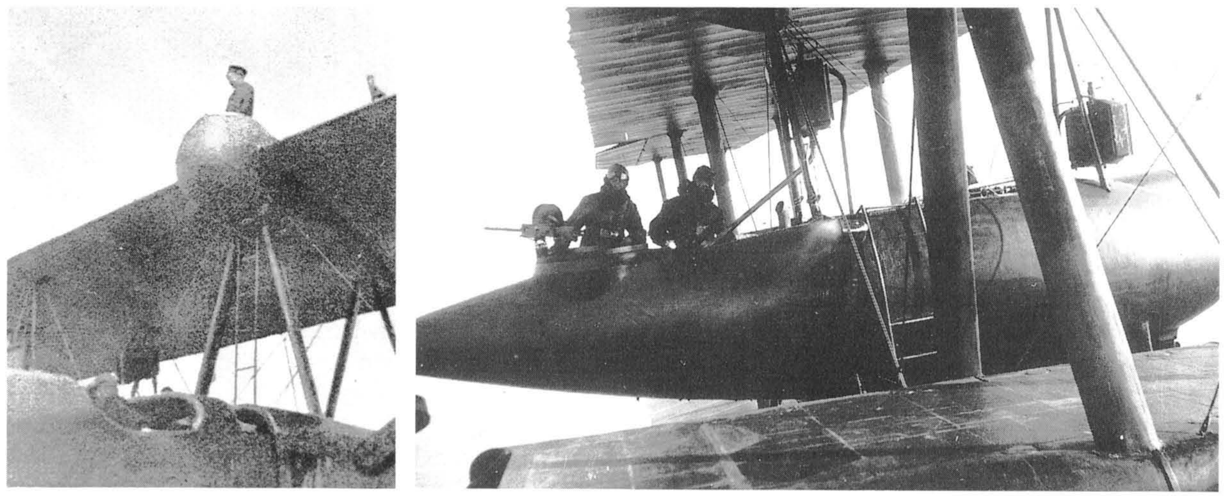
Staaken R.V 13/15. The engines are being tested in preparation for a night mission from Scheldewindeke in 1918.



was installed above the fuselage nose and the remaining four were attached to the front and rear upper nacelle struts, staggered to avoid blanking each other.

Wing construction and dimensions were identical to the previous Staaken machines. Night-landing lights were fitted in the lower-wing leading edge in front of the inner struts.

The fuselage, though structurally similar to earlier Staaken machines, was considerably shortened from the centre-section struts aft. This segment and tail presaged the construction of the R.VI machines. Crew accommodations followed the pattern set by the VGO.III. The flight mechanic's compartment was located directly behind the nose engine, followed by a large open pilots' cockpit and a similar open commander's position. Dorsal and ventral machine-gun positions, located behind the centre section, supplemented the strong tail defence. To provide a forward-firing gun position the gravity tank was encased in a streamlined pod which extended ahead of the upper-wing leading edge. A machine-gun post, known as the "Swallow's Nest", was located in this extension and could be reached by a ladder set between the centre-section struts.



Gun positions of the Staaken R.V.

Strange as it may seem, the R.V was fully equipped with a pneumatic-tube message system with six receiving and sending stations. The problem of communicating in an R-plane was difficult to solve. Various attempts were made in the early giants to use such forms of acoustical communication as telephones, sirens and speaking-tubes. But these failed due to the loss of hearing experienced by crews during long flights. Optical devices ranged from the simple chalkboard to complicated optical systems, such as writing on frosted glass and projecting the message through prisms and lenses on to an opaque surface. Another technique which met with little success was to run messages along a wire track from station to station. In the end, the pneumatic-tube device, although an acceptable technique, lost out to the simpler electric telegraph, which used ten or twenty pre-set signals to furnish information and commands. The pneumatic telegraph in the R.V was operated by turning a crank: a right-hand turn created air pressure and a left-hand turn created suction. A signal light automatically lit in the receiving station when a message was placed in the tube.

It is known that Lt. Otto Reichardt was transferred to Gotha to take command of the R.V. It may be assumed that the R.V was the last Staaken R-plane to be built in Gotha and that Dipl.-Ing. Lt. Reichardt was responsible for bringing the R.V up to operational status. The crew of the R.V, larger than in most R-planes, numbered eleven men, consisting of one commander, two pilots, three mechanics, one wireless operator, one fuel attendant and three gunners.

The R.V 13/15 was accepted at Staaken on 29 September and joined Rfa 501 at Ghent on 23 December 1917. Its first bombing mission was on 25 January 1918 when it attacked harbour installations at Calais. During its eight months service career, the R.V flew only sixteen combat

missions. This low total is a reflection of the recurring mechanical failures which plagued the power transmission system. The most notable mission recorded in the R.V war diary took place on 7/8 March 1918 when the R.V carried a useful load of 4771 kg. at an altitude of 3300 metres on a flight lasting seven hours[1]. Although the right front clutch failed over London, the R.V returned home safely. Lt. Reichardt was transferred home during late 1918 to serve with Idflieg, where he utilized his experience as front-line pilot and R-plane commander to institute a series of improvements which, it is said, greatly increased the performance of the Staaken R-planes. Later in 1918 he was killed while assisting in the development of the AEG R.I.

Waldemar Roeder recalls his flying as second pilot on the R.V while serving with Rfa 501. The commander was Lt. Ernst Pickerott and first pilot, Vizefeldwebel Heinz Schmitz. The flying qualities of the R.V, as with all Staaken aircraft, were rather comfortable and stable, if one disregards the rather high control forces, particularly the unbalanced ailerons. The steering wheel had to be turned several times until the ailerons "caught", and then it took considerable time until the aircraft reacted.

With the fusion of Rfa 500 and Rfa 501 the R.V flew to Morville in October 1918. On 18 October 1918 the R.V was ordered to Düsseldorf-Lohausen. During the flight, fog was encountered in the Rhein area. Much against the better judgment of Schmitz and Roeder, Pickerott ordered an emergency landing. In the attempt, the aircraft was smashed, although the only injury to the crew was a broken ankle suffered by Lt. Pickerott. The crash occurred in what became the Allied Zone of Occupation, and it is entirely possible that reports by former squadron members are true, namely that the aircraft, or parts of it, were delivered to the Allied armistice commission.

Colour Scheme and Markings

The overall finish consisted of large vari-coloured polygons. White outlined Patée crosses were painted on upper and lower wingtips, fuselage sides and tail.

SPECIFICATIONS

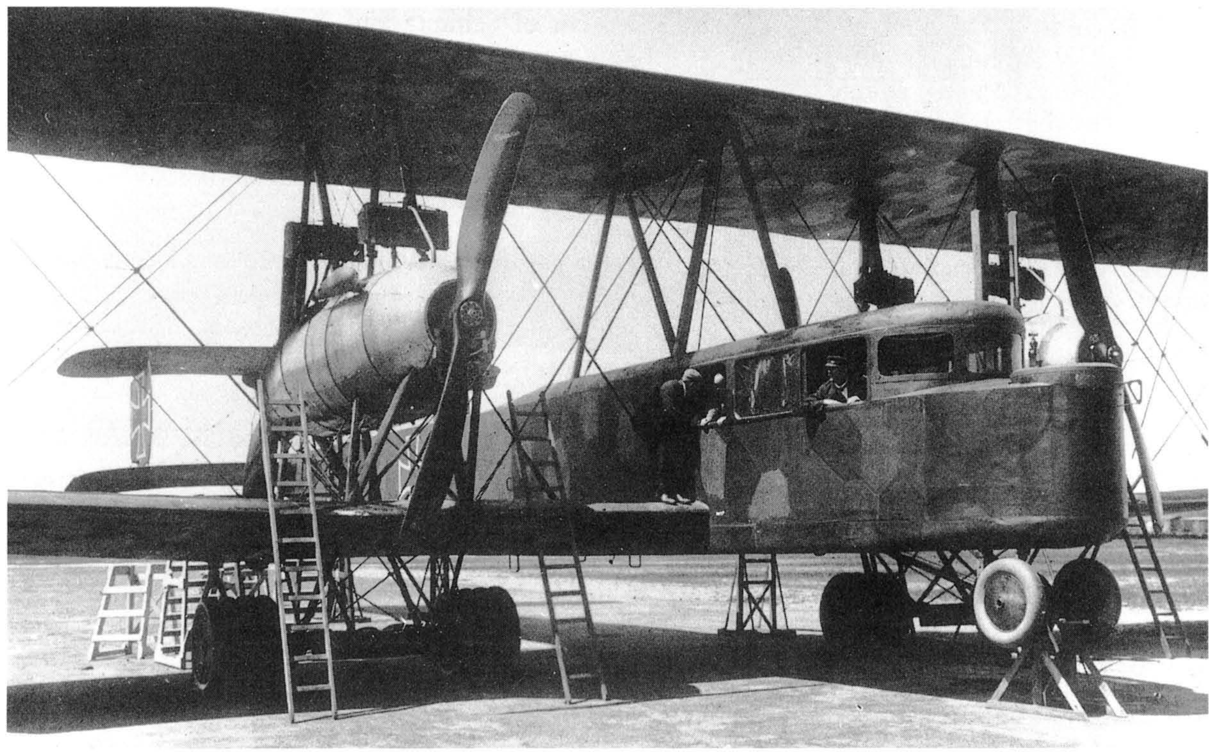
Type:	Staaken R.V.
Manufacturer:	Flugzeugwerft G.m.b.H., Staaken, Berlin
Engines:	Five 245 h.p. Maybach Mb.IVa engines
Dimensions:	Span, 42·2 m. (138 ft. 5½ in.)
	Length, 23 m. (75 ft. 5½ in.)
	Height, 6·8 m. (22 ft. 3½ in.)
Areas:	Wings, 332 sq. m. (3572 sq. ft.)
Weights:	Empty, 9450 kg. (20,837 lb.)
	Useful load, 3560 kg. (7,850 lb.)
	Loaded, 13,010 kg. (28,687 lb.)
Wing Loading:	42 kg./sq. m. (8·6 lb./sq. ft.)
Performance:	Maximum speed, 135 km.h. (83·9 m.p.h.)
	Climb, 1000 m. (3281 ft.) in 10 mins.
	2000 m. (6562 ft.) in 22 mins.
	3000 m. (9843 ft.) in 34 mins.
	Ceiling approximately, 4500 m. (14,764 ft.)
Armament:	Provision for dorsal, ventral, upper wing and two nacelle machine-gun positions.
Service Use:	Western Front with Rfa 501 in Ghent area 1917–18

[1] See Appendix 1 for R.V flight log.

Staaken R.VI

The development cycle of the Staaken R-planes reached its first plateau with the introduction of the Staaken R.VI. This aircraft was not only the largest aircraft to go into quantity production during World War I but it was also the best known of all the German R-planes. In all, a total of eighteen R.VI machines were constructed (excluding the seaplane versions), but only six of these were actually produced by the parent company. The remainder were manufactured under licence by the following firms: Automobil & Aviatik A.G., Leipzig-Heiterblick; Luftschiffbau Schütte-Lanz, Zeesen and the Ostdeutsche Albatroswerke G.m.b.H., Schneidemühl.

As one would expect, the design of the R.VI drew heavily on the earlier Staaken types, with the exception that the fuselage-mounted engine or engines were discarded in favour of four tandem push-pull engines installed in the nacelles. This configuration had not been tested in any Staaken machine prior to the R.VI, but the change was dictated by operational experience.

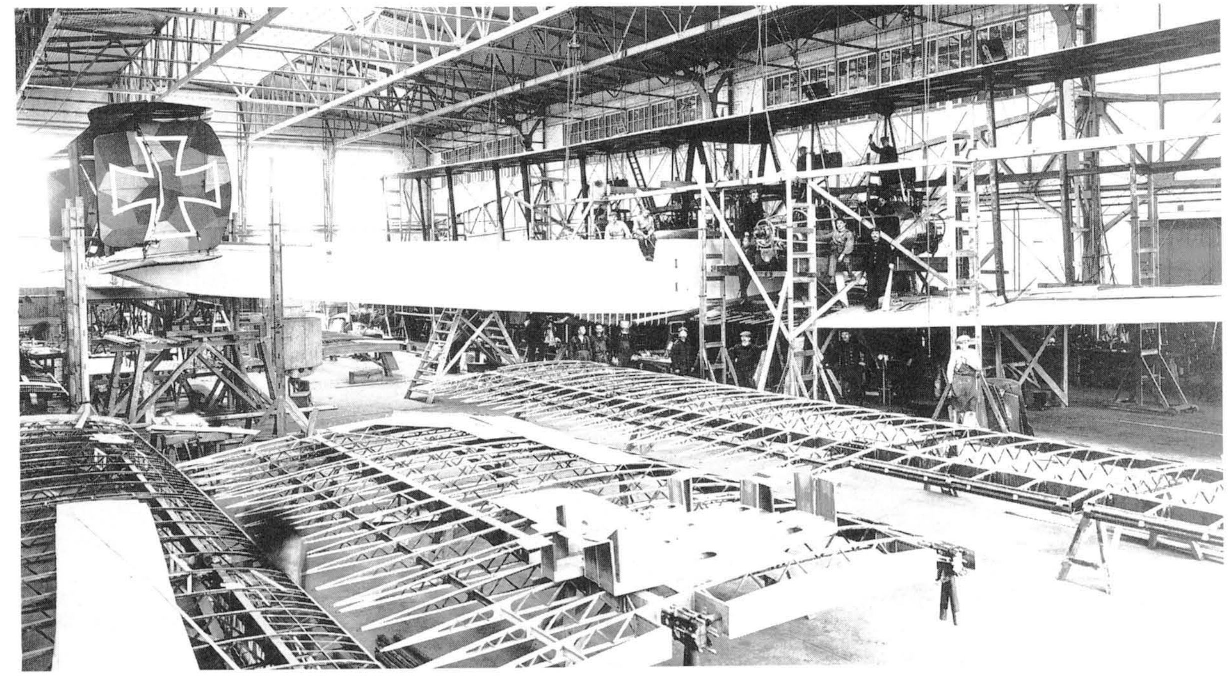


Staaken R.VI 25/16.

The large-diameter nose propeller required a fairly high landing gear, which in turn increased the chances of nosing over during hard landings on rough terrain. Furthermore, the nose engine was thought to increase the danger of fire due to the proximity of the fuel in the fuselage.

From a military standpoint, it was imperative that R-plane construction be accelerated. For this reason, it was decided to eliminate the complex and costly gear-box–coupled engine arrangement, which had not proved entirely reliable and required highly-trained crews to operate. Expert maintenance was responsible for the successful operation of the coupled system in the R.IV, but with the installation of higher-powered engines, the mechanical reliability dropped appreciably. Consequently, a simple push–pull tandem engine arrangement was chosen which became a standard fixture on subsequent Staaken aircraft.

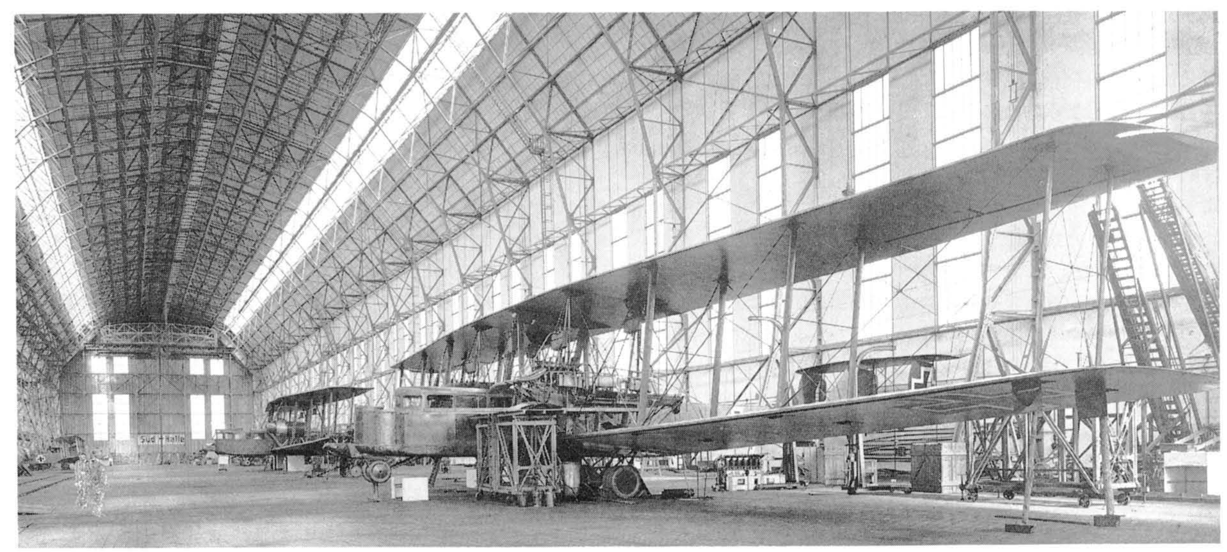
By the middle of 1916 exhaustive tests on the efficiency of tandem propeller arrangements had been



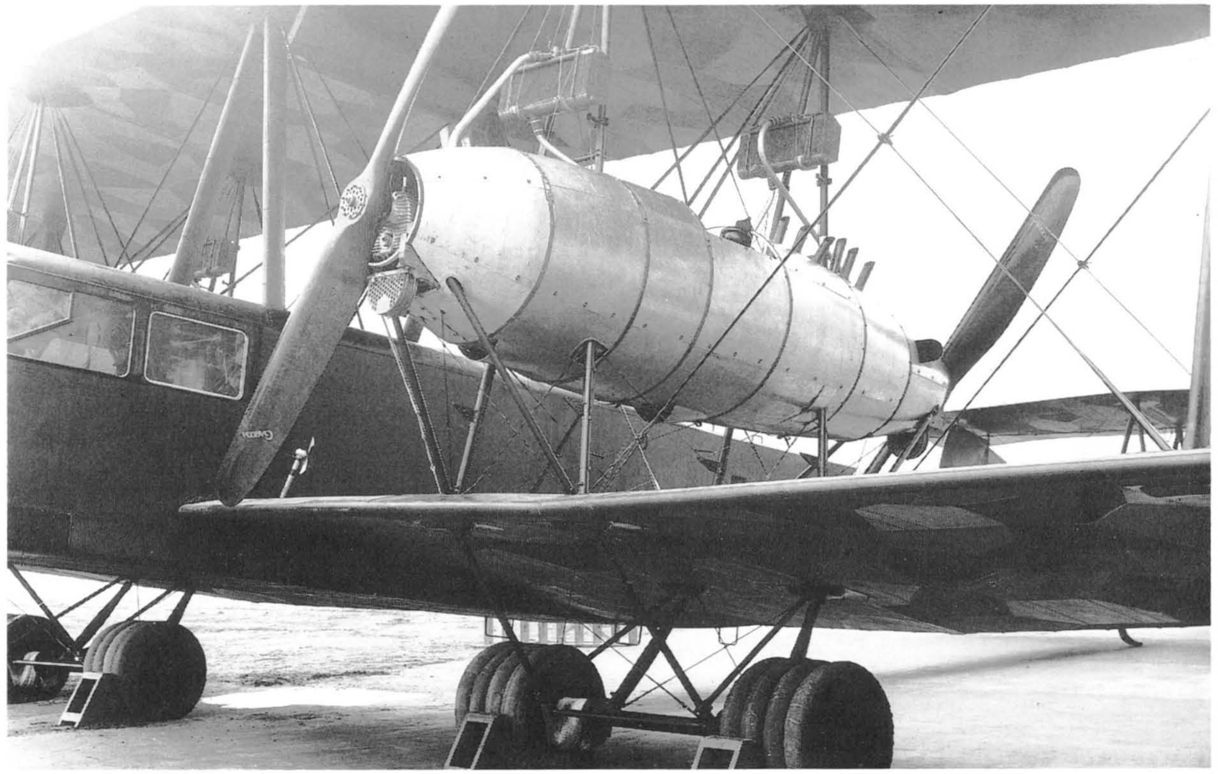
The Staaken R.VI (Av) 33/16 under construction.

completed by the Zeppelin-Werke Lindau (Dornier), and test results showed that tandem propellers were almost as efficient as propellers operating alone. This information was undoubtedly passed on to the Staaken branch of the Zeppelin combine and played its part in the development of the R.VI.

The first R.VI, the R.25, was probably completed during the latter half of 1916 and was extensively test-flown by Staaken and Army engineers before being delivered to the air service on 8 June 1917. It was followed closely by the R.26, which was delivered on 20 July 1917. The success of the trials led to the awarding of licence contracts to Aviatik, Schütte-Lanz and Ostdeutsche Albatroswerke during the winter of 1916 and the spring of 1917. The activities of these companies have been described in a separate chapter, and further details regarding each aircraft can be found at the end of this chapter.



Staaken R.VI 30/16 being fitted with supercharger in the Staaken airship hangar. In the background is the Staaken R.XIV 43/17.



Staaken R.VI (Schül) 27/16

Because the construction particulars of the Staaken R.VI are common to most of the Staaken aircraft, they are described in greater detail in this section. The R.VI was powered either by four 260 h.p. Mercedes D.IVa engines or four 245 h.p. Maybach Mb.IVa engines. Judging from company records, the R.25 to R.38 were initially powered by Mercedes engines, but several of these machines were later fitted with Maybach Mb.IVa engines. The latter was one of the first "overcompressed" engines developed by the Germans for altitude use. The Mb.IVa had finished tests in the special high-altitude chamber at the Maybach factory in August 1916 and was offered to the Government in October 1916. The engine was designed to give full power at 2000 metres altitude by increasing the cylinder bore and the length of the piston, which raised its compression ratio. The Mb.IVa could not be run at full power below 2000 metres due to premature ignition of the fuel mixture, which resulted in harmful overheating of the engine. Its power output of 2000 metres was rated at 245 h.p., which would be equivalent to the output of a standard 300 h.p. engine at that altitude. A special stop prevented unintentional opening of the throttle at lower altitudes. The reason that the Mb.IVa was designated as a 260 h.p. engine in many official records has been explained as follows: "The '260 h.p.' designation was applied to the 245 h.p. Mb.IVa so that it would not, as a new engine, appear inferior in horse-power to the older 260 h.p. engines which it replaced."

The engines were mounted in the front and rear of each nacelle and independently drove a single propeller through a reduction gear-box and short transmission shaft. The rear engine shaft was longer than the front to place the pusher propellers clear of the trailing edges of the wing. The engine was separated from the gear-box by a combination leather–metal knuckle coupling to absorb vibrations and misalignments. Gear-box oil was cooled by a small semicircular cooler which extended into the slipstream below the nacelle.

Four radiators were mounted on struts above the nacelles and, as on previous machines, the rear radiator was located higher than the front. The radiators used on the R.VI varied, and included those built by Windhoff, N.I.W. and Daimler.

The engines were equipped with self-starting mechanisms because "swinging the propeller" by hand

was obviously impractical. The Mercedes engines were fitted with a simple Bosch electric starter powered by an accumulator. The Maybach engines were equipped with a novel self-starting device unique to that engine. The procedure consisted of pulling a lever which simultaneously lifted exhaust and intake valves and closed a shutter in the exhaust manifold. By action of a large hand suction pump connected to the exhaust manifold, fuel was drawn into the cylinders from the carburettor. When the engine was primed the valves were returned to their original position, and ignition was then effected by means of a Bosch hand-starter magneto. At a later date a field modification made by the R-plane squadrons was the addition of the Staaken hand-cranking device to facilitate the drawing of fuel into the cylinders.

The engine nacelles were fashioned from U-shaped aluminium stringers and covered with aluminium panels held in place by hinges and leather straps. A small cockpit for the flight mechanic was situated between the engines. The nacelles were supported in the wing gap by two inverted V-struts, the ends of which were attached to the lower and upper wing spars. At about one-third of its height the inverted V was joined by a transverse box girder of welded steel to form an elongated A to which the engine bearers, which spanned the entire length of the nacelle, were attached. The bearers consisted of ash planks sandwiched between two layers of heavy plywood. Additional struts ran from the lower wing spars to the ends of the engine bearers to provide extra support for the gear-boxes.

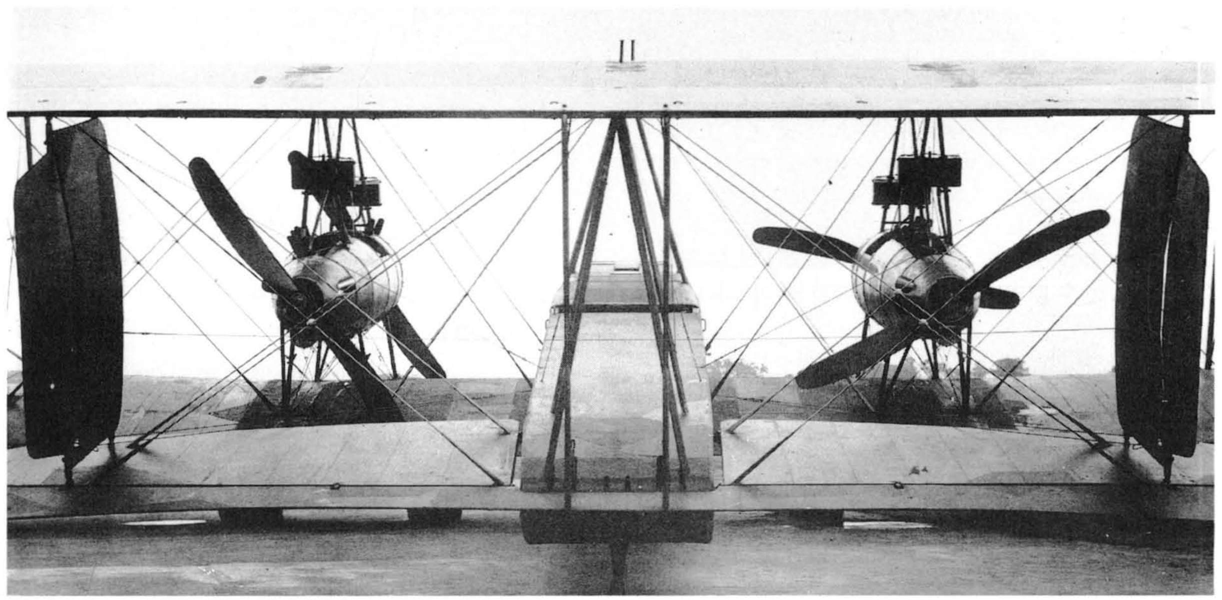
In most instances the propellers were supplied by Garuda. They were built of spruce and ash laminations and then covered with a thin sheathing of plywood. Large blunt spinners were fitted to the propellers of the Aviatik-built R.VI machines.

Eight (and on some machines ten) cylindrical fuel tanks were installed in the central fuselage section, each with a capacity of 245 litres. The tanks were suspended by steel bands attached to the upper fuselage frames, which were, at this section, reinforced by a welded steel tube structure. A gangway between the tanks allowed the crew to inspect them and to pass between. Fuel was pumped to a 155 litre gravity tank by two propeller-driven pumps mounted either on the fuselage decking or

Staaken R.VI (Schül) 27/16 Photo dated 17 October 1917.

at the fuselage sides near the wing roots. The streamlined gravity tank was located under the upper wing between the cabane struts. In an emergency the fuel in each main tank could be jettisoned by a quick-emptying valve. A fuel attendant governed the level of the individual fuel tanks so that the trim of the aircraft was not disturbed during flight.

In form and construction the four-bay wings were almost identical to those on the earlier Staaken R-planes. Both upper and lower wings had equal span and outline, swept-back leading edges and lower wing dihedral. Each wing consisted of three parts, a centre section and two outer panels. The wings were built around two main spars built-up from seven ash (upper wing) and spruce (lower wing) mouldings to form a double-box cross-section. Ash was utilized in the upper wing because of its higher compressive strength, whereas spruce was used in the lower wing for its superior tensile strength and lighter weight. The individual spar mouldings were glued together and reinforced with ash tongue-and-groove joints. The whole spar length was then covered on two sides by a 2·5 mm. layer of glued plywood. Finally, the spars were wrapped in glue-soaked cotton cloth. The outer wing panels were joined to the centre section with steel collars and bolts.



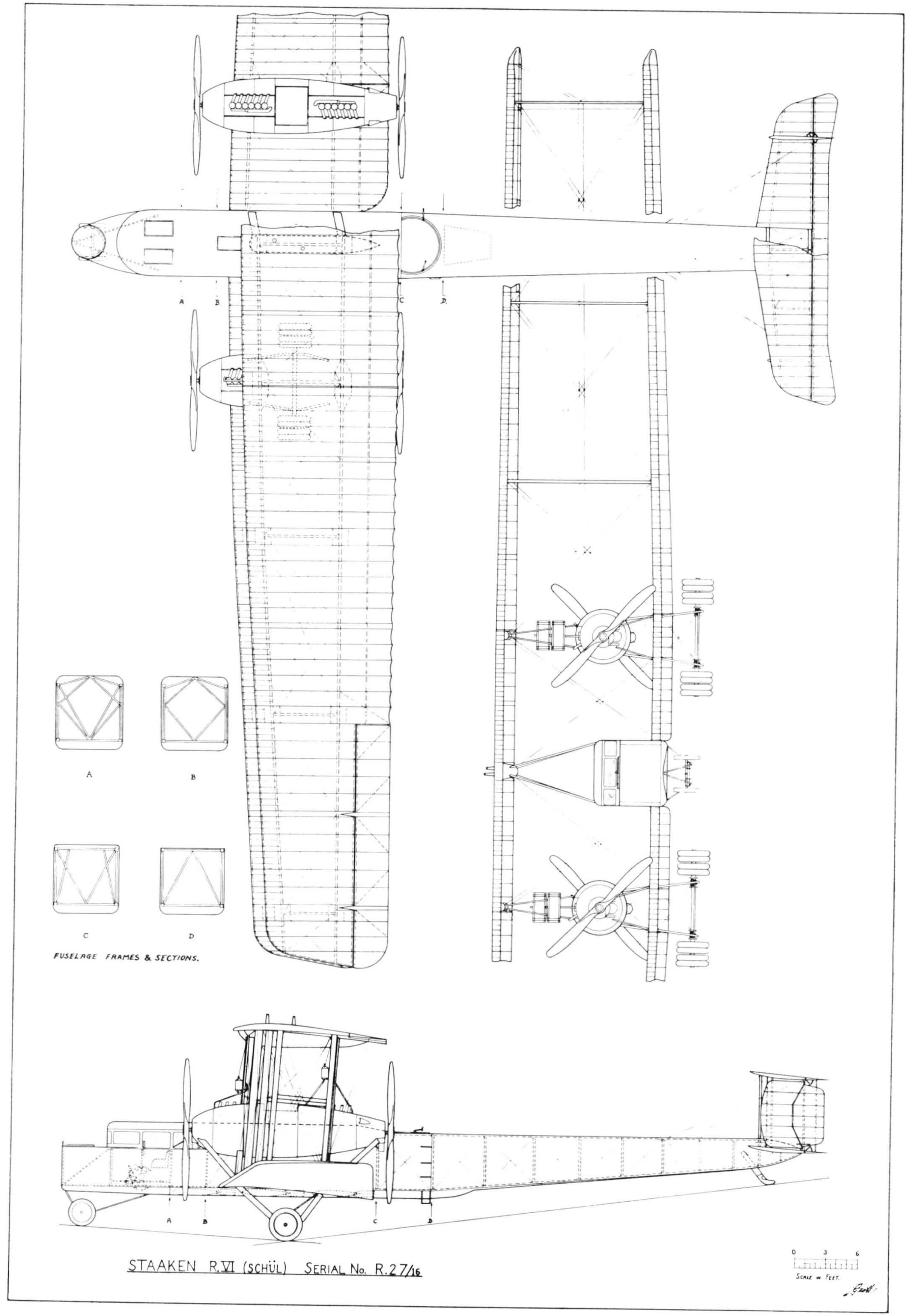
Staaken R.VI (Schül) 27/16.

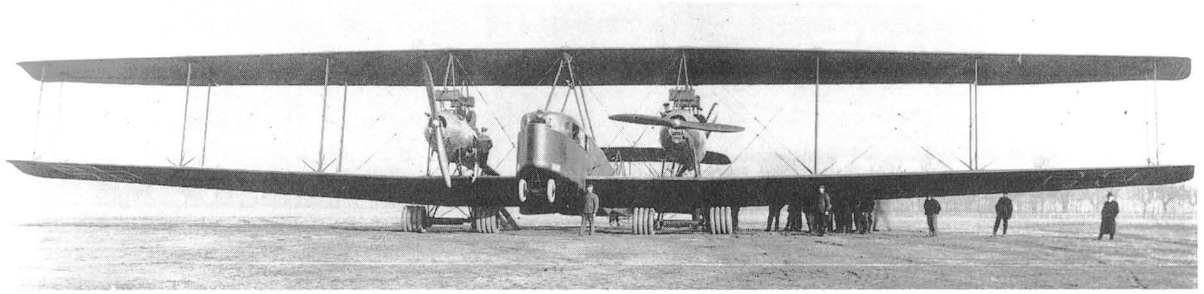
The wing ribs were fabricated from spruce, and the rib spacing varied throughout the span, the distance between ribs being less where the stress was greatest. False ribs running from leading edge to front spar maintained correct rib profile at the leading edges.

Steel compression tubes were fastened between the spars at all strut attachment points. The wing was internally braced by two sets of cables; one set crossed between adjoining compression tubes; the other ran from the compression tubes to double ribs which were spaced midway between strut attachment points. The wing struts consisted of faired steel tubing, the diameter of which decreased with increasing span. External wing bracing was composed of double cables throughout. The wings were rigged with slight negative stagger and a rather pronounced incidence, which gradually decreased towards the wingtips.

The unbalanced ailerons were fitted to the top wings only, and they conformed to the outline of the wing. The steel-tube, fabric-covered ailerons were hinged to false spars in the wing and actuated by cables running from bell-cranks down through the lower wing. The Aviatik-built machines (R.52–R.54) had ailerons with extended balancing areas, and the R.30 was equipped with R.XIV pattern ailerons.

Initially, the single-bay biplane tail assembly was identical to that of the Staaken R.V; however, at

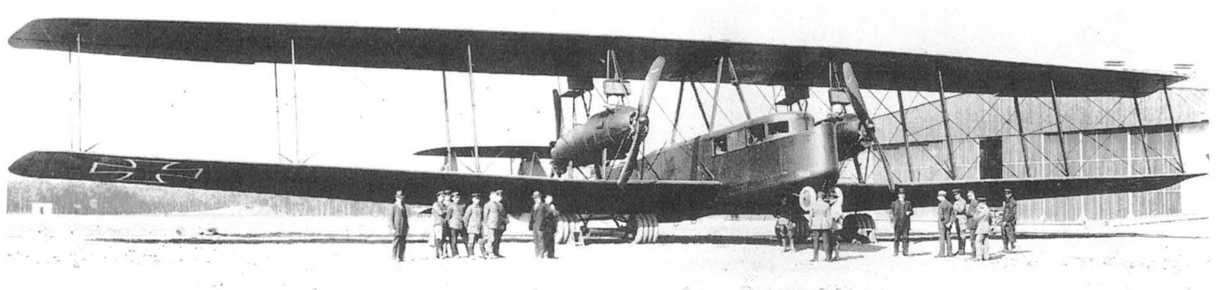




Staaken R.VI(Schül) 28/16. Although eight-wheeled undercarriages were deemed adequate for hard surfaces, operation on sandy airfields required doubling the number of wheels to sixteen. Photo dated 5 February 1918.

a later date a central fin and rudder were added to counter the control losses due to fuselage twisting. The tailplanes, similar in construction to the wing, used spruce ribs and spars and aluminium tubing for the compression members. The tailplanes were flat on top, cambered underneath, and they were set at an unusually large angle of incidence of 6 degrees. Elevators were fitted to both tailplanes. The interplane struts formed the king-post supports for the characteristic Staaken fin and balanced rudder. All tail surfaces, with exception of the tailplanes, were built of aluminium and covered with fabric.

The steel-tube undercarriage was a simple robust structure considerably shorter than earlier Staaken types. The massive axles were generally equipped with four wheels at each end, although a few R.VI machines had only two wheels of larger diameter at each axle end. Rubber shock cords were employed in most cases, but later aircraft used bundles of coil springs. A short twin-wheel auxiliary undercarriage was mounted on the nose of all R.VI machines, but it was used only on



Staaken R.VI (Schül) 28/16. Fitted with upper wing gun position. Photo dated 18 May 1918.

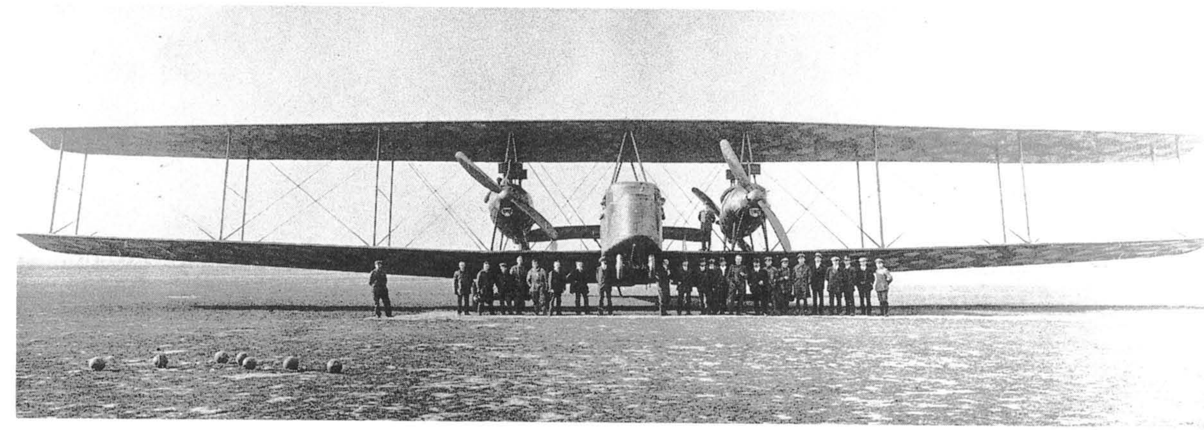
touch-down. Contrary to the earlier Staaken machines, the normal ground attitude of the R.VI was for the machine to rest on its tail skid.

The fuselage was basically a lattice-girder structure composed of mixed wood and steel tube construction. The two upper longerons were spruce and the lower ash, fabric-wrapped for their entire length. The frames were welded steel tubing, and those in the rear of the fuselage were of rectangular form, while at the centre-section and nose they were reinforced by diagonal tubes, forming a triangular structure. The forward fuselage was encased in plywood and the remainder was covered with fabric.

The control cabin, inside and out, was quite modern in appearance for those days. The cabin was fully enclosed, with sliding windows that extended back to the leading edge of the wings. Black shades could be drawn across the windows to avoid dazzle. Two pilots sat on each side of the cabin behind two massive automobile-type steering wheels. The engine throttle controls were located between their seats within each reach, and were grouped in such a fashion that they could be manipulated singly or in unison. The all-important master ignition switch was located immediately behind the throttles,

protected by a safety cover. The timely short-circuiting of engines and electrical circuits was responsible for saving several R-planes from destruction by fire after crash landing.

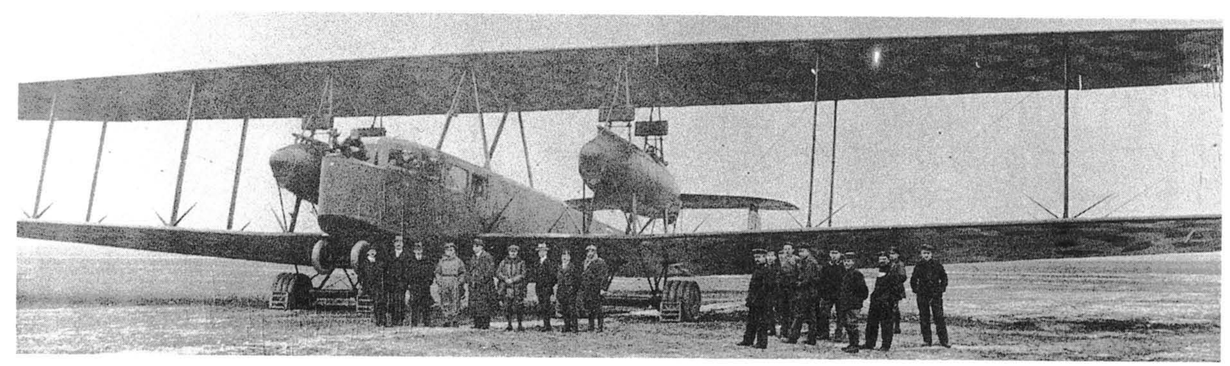
Initially, a standard gimbal-mounted floating compass, built by Ludolph and adapted from airships, was mounted directly in front of the throttle levers. Its weight and unreliable operation led to the development of a large drum-type compass for R-planes. However, this compass did not perform as desired due to the lack of suitable magnetic alloys. Furthermore, its installation presented certain difficulties, particularly if its magnetic field were placed near steel frames, electric circuits and tachometers. The large drum compass was discarded in favour of two small drum compasses mounted outboard of the pilots' seats The final solution was not achieved until the Bamberg repeater compass was installed in the rear of the fuselage. The course could be set with a flexible shaft, while an electric repeater indicated every variation from the set course. The aircraft commander was supplied with a charting compass for use on his navigating table and a bearing compass for taking visual bearings.



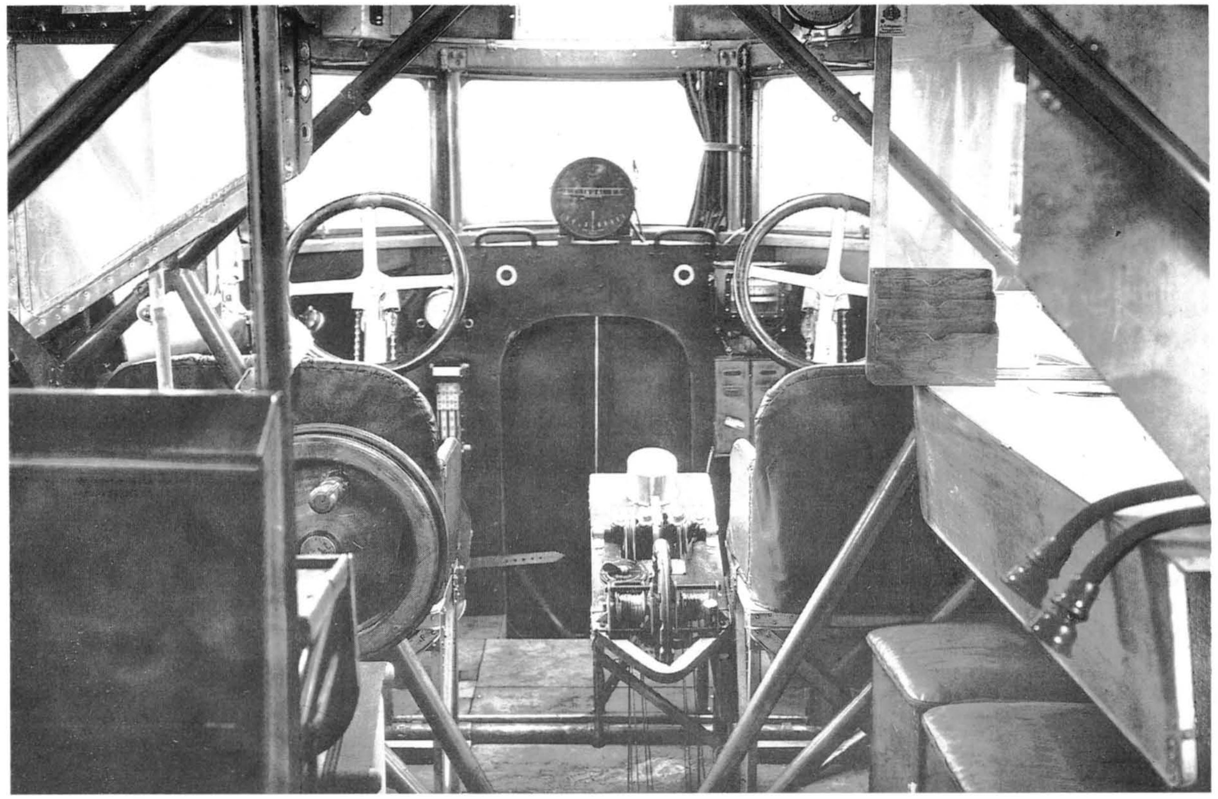
Staaken R.VI (Av) 33/16.

Astronomical navigation was attempted, but the shortage of personnel precluded greater use of the technique and forced the development of wireless position-fixing techniques.

Instruments installed in the pilots' cabin included direct-reading and recording altimeters, a variometer for measuring rate of climb, four electric tachometers, a clock, two air-speed indicators (one for each pilot), a thermo-electric engine-temperature indicator with a switch for reading ten stations and a fluid inclinometer. The final piece of equipment for the pilots was the artificial horizon. Earlier R-planes, R.VI included, were fitted with the Anschütz gyro inclinometer or artificial horizon, which could indicate bank and fore-and-aft inclination. However, the gyro used in the Anschütz system was not free of centrifugal effects and required some 10–15 minutes to reach its operating



Staaken R.VI (Av) 34/16.



Pilot's cabin of Staaken R.VI 31/16.

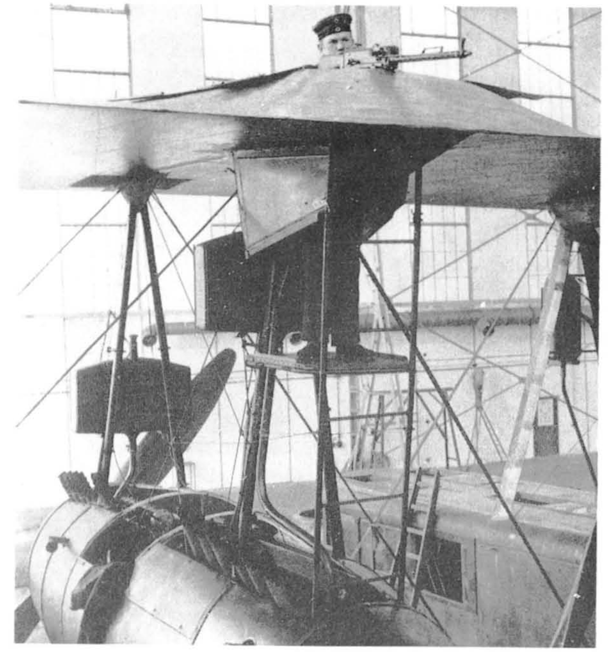
speed, which meant it could not be used during take-off due to the electrical system involved. To correct the first shortcoming, the weight of the gyro was raised to some 40 kg., which made its use almost prohibitive from a weight standpoint. During mid 1917 the Drexler bank-indicator was introduced. It was a lightweight (5 kg.), greatly simplified gyro device that operated on the precession principle. It reached running speed in less than a minute and was powered by a small propeller-driven generator.

The electrical machine telegraph by which pilots and mechanics communicated was fixed to the roof of the cabin. Twenty or more commands could be transmitted by means of pre-set words indicated by light bulbs.

The wireless sending and receiving equipment was located on the port side, behind the pilot. The commander's navigation table was situated in close proximity across the gangway. The wireless equipment was powered by a 2·5 h.p. Bosch petrol-driven generator which supplied 1000 watts. During wireless silence the Bosch generator could provide electricity for heating the flying suits of seven men and charge the batteries which provided electricity for the lighting system. The lighting could be controlled by the pilots to achieve any degree of illumination. Interior lights were covered with blue glass to reduce glare and danger of being spotted. It was customary to install a battery of six landing lights under the fuselage. In addition, two lamps were installed behind the landing gear to throw its shadow on the ground to provide a means for judging height while landing.

An observation post was located in the extreme nose, with provisions to mount a machine-gun. It was from this position that the aircraft commander directed the bomb run, and this is where the bomb sight was mounted. The dorsal position was equipped with two flexible machine-guns, and the ventral machine-gun was mounted on a small ramp that could be lowered slightly. Two R.VI machines, possibly several others, were equipped with upper-wing mounted guns in the manner of the Staaken R.IV. They differed by having their undersides faired and instead of sliding panels,

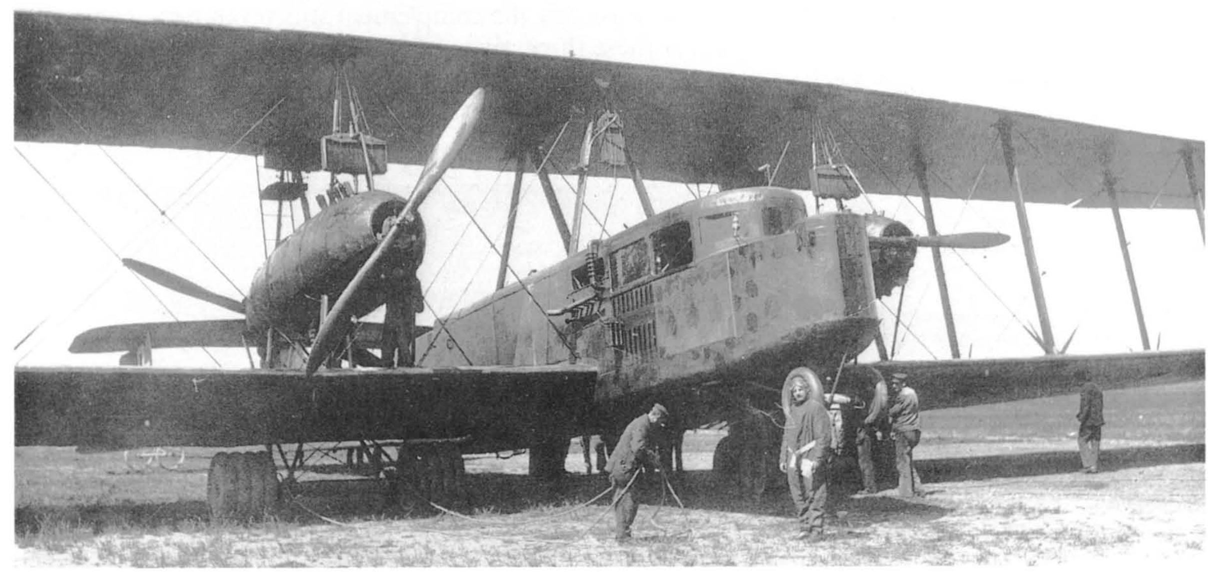
folding trap-doors provided some protection from the slipstream when lowered. The official German *Equipment Tables for R-planes* specified three Lewis machine-guns as the normal armament to be



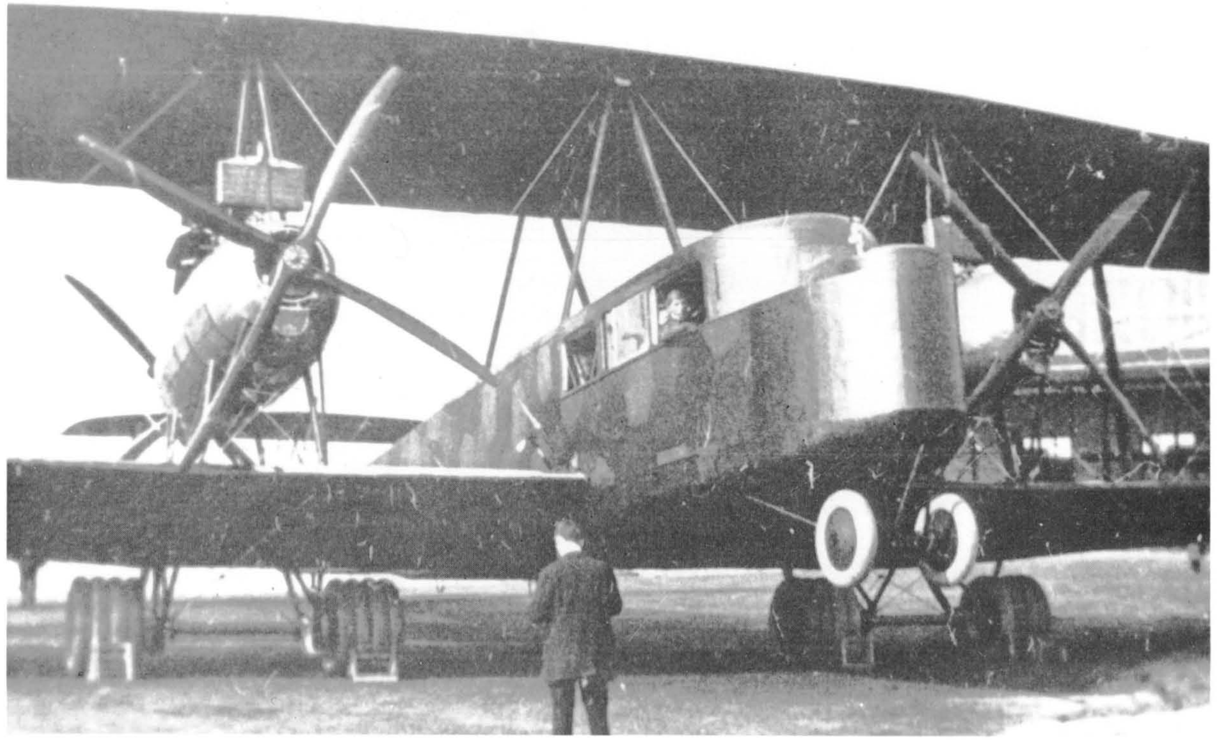
Upper wing gun position on the R.30.

carried by the R.VI. These guns were considered by all the combatants to be a superior weapon in the air, as its extreme lightness made it an ideal free gun.

The bomb load was carried internally in the central section of the fuselage underneath the fuel tanks. Bomb racks for eighteen 100 kg. bombs in three rows of six each were provided, but the 300 kg. and



Staaken R.VI 30/16.

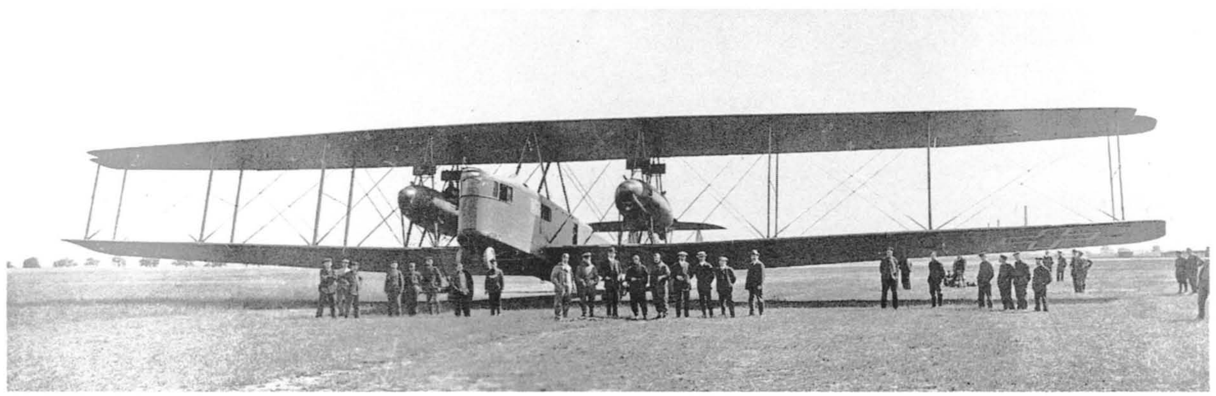


Staaken R.VI 26/16 experimentally fitted with four-bladed propellers.

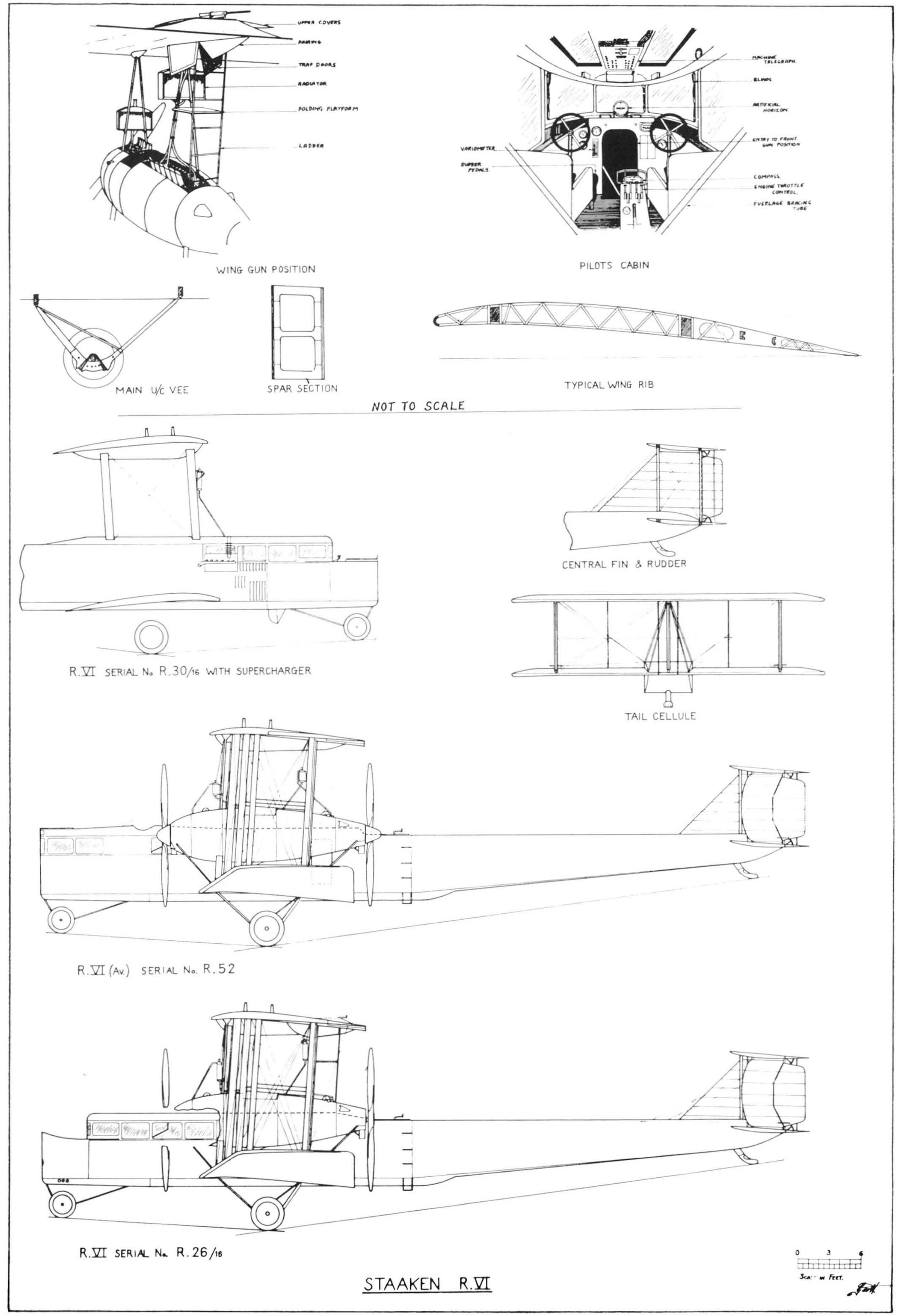
1000 kg. bombs had to be carried semi-externally. The bomb load varied according to the distance travelled, i.e. the amount of fuel carried. For short distances a bomb load up to 2000 kg. could be lifted, but for long ranges a load of 1000–1200 kg. was more normal.

The usual flight duration of the R.VI was about 7 hours, which could be stretched to 10 hours if additional fuel tanks were installed. The machines generally flew non-stop from Döberitz to airfields in the Ghent area, some 740 km., on their delivery flights. The longest operational raids were those flown against Le Havre, when a total distance of 800 km. was covered. The maximum range was 900 km. on 3200 litres of fuel and carrying a bomb load of 750 kg.

The crew varied according to the mission, but generally the complement was seven men, consisting of the commander/navigator and two pilots (of these three, two were usually commissioned officers), a wireless operator, two flight mechanics and a fuel attendant. For additional protection one or two gunners could be accommodated, but this was the exception rather than the rule.

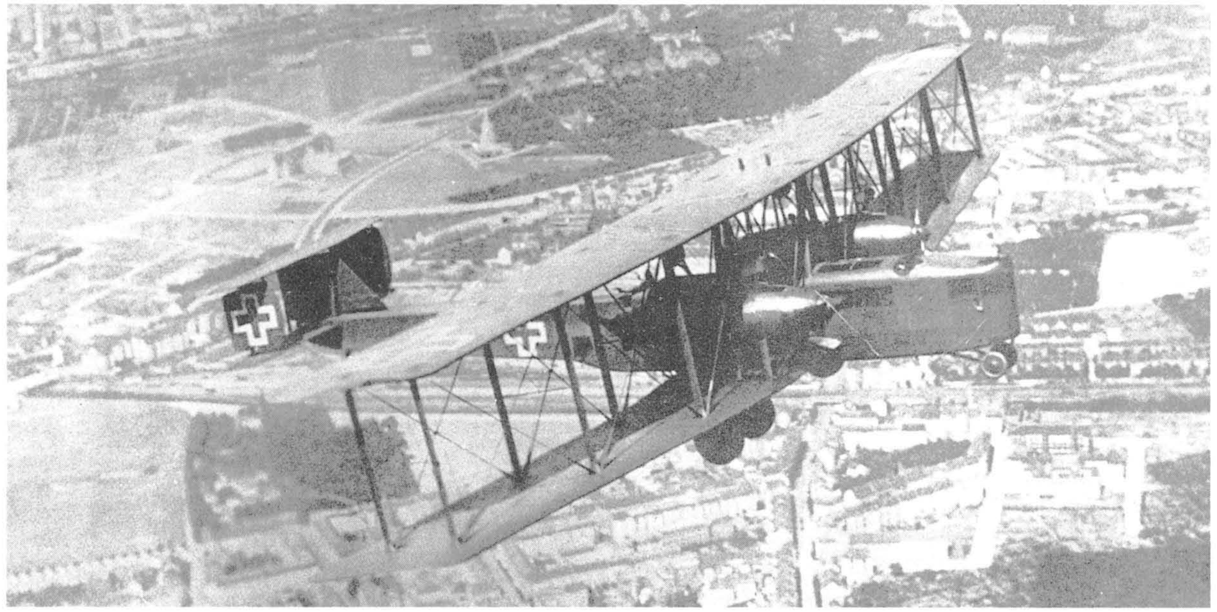


Staaken R.VI (Av) 52/17.



The Staaken R.VI formed the backbone of the German R-plane squadrons on the Western Front, and carried the brunt of the attack up to the end of the war, but not without severe losses. Out of the eighteen Staaken R.VI machines built, eleven aircraft (possibly more) are known to have been destroyed in the war. Of the eleven, seven made crash landings (R.26, R.27, R.29, R.32, R.34, R.36, R.38); one was lost due to engine failure at take-off (R.28); two were shot down (R.31, R.37) and one crashed as a result of extreme flight manoeuvres (R.52). The effects of weather and the danger of making an emergency landing at night were the chief threats to the operational R.VI bombers. Only two R.VI were definitely shot down by defence forces; the R.37 by anti-aircraft fire near Betz while returning from a raid on Paris and the R.31 by a 151 Squadron night fighter.

The R.VI was joined by more powerful Staaken types which began to reach the Front in late 1918.



Staaken R.VI(Av) 52/16 during a test flight over Leipzig.

Yet the R.VI remained in operational service until the end of the war, and several machines that survived were used in civil ventures in post-war Germany. An engine nacelle identified by the engine serial numbers as belonging to the R.35 is on view at the Polish Air Museum in Krakow.

Colour Scheme and Markings

Most of the R.VI aircraft were covered with printed camouflage fabric, the pattern used varied according to the manufacturer. The fuselage fabric of the Staaken-built R.VI machines was painted in a dark colour consisting of an undercoating of colourless acetate dope covered by pigmented dope, coloured blue by a mixture of Prussian blue and ultramarine blue.

National markings were painted on the wingtips, fuselage and tail in the style authorized at the particular period. The Patée crosses of the first Aviatik-built series were represented by white outlines only.

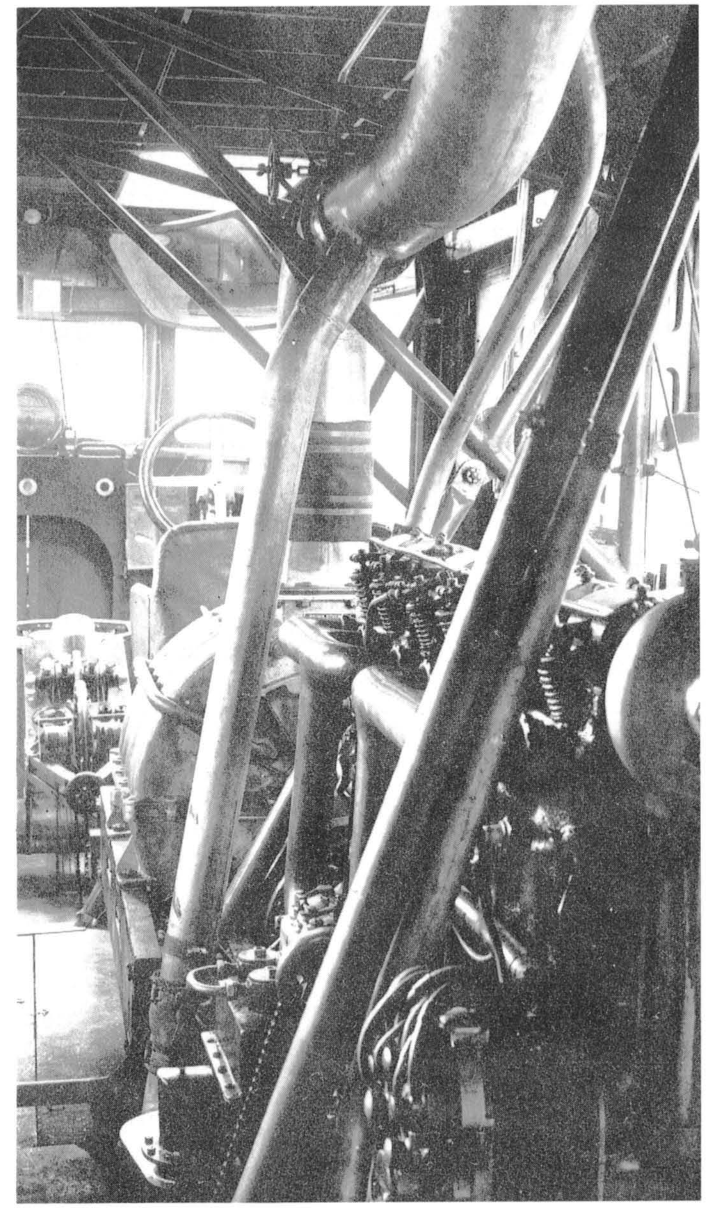
Some R.VI had serial numbers painted in large white figures on the rear fuselage sides, a practice fairly common in late 1918.

Notes on individual Staaken R.VI Aircraft

R.25. Staaken built. Four 260 h.p. Mercedes D.IVa engines. Built late 1916. Accepted 6 June 1917. Sent to Rfa 500 for trials on Eastern Front. On 28 July completed a $6\frac{1}{2}$ hour test flight with combat load. Flown to Cologne on 5 August. Operational with Rfa 501. Executed the successful lone attack on St Pancras Station 17/18 February 1918. Commanded by Lt. Max Borchers.

R.26. Staaken built. Four 260 h.p. Mercedes D.IVa engines. Accepted 24 July 1917. Operational with Rfa 501. Commanded by Oblt. Fritz Pfeiffer, piloted by Lt. Wilhelm Pier. Crash landed in fog and burnt at Scheldewindeke 9/10 May 1918.

R.27. Schütte-Lanz built. Four 260 h.p. Mercedes D.IVa engines. Acceptance flights in October 1917. Flown from Döberitz to Rfa 501 on 23 January 1918. Commanded by Hptm. Schoeller on England raids. Crash-landed due to frozen fuel lines in Belgium, 7/8 March 1918. Crew uninjured, engines and instruments salvaged, remains destroyed by enemy gunfire.



Interior view of the R.30, showing the supercharger and its petrol driven engine.

R.28. Schütte-Lanz built. Four 245 h.p. Maybach Mb.IVa engines. Completed late 1917, accepted 12 February 1918. Flew from Zeesen to Cologne on 5 June 1918. Operational with Rfa 500. Commanded by Hptm. Schoeller. Crashed 15/16 September 1918 as a result of engine failure.

R.29. Schütte-Lanz built. Initially four 260 h.p. Mercedes D.IVa engines. Ready for first flight in

February 1918. Four 245 Maybach Mb.IVa engines installed and other modifications made in March–April 1918. Fitted with upper-wing gun positions. Accepted on 1 May 1918. Flew to Rfa 501 on 3 May 1918. Crashed into trees while landing in fog at Scheldewindeke 9/10 May 1918.

R.30. Staaken built. Four 260 h.p. Mercedes D.IVa engines. Acceptance flights in October 1917. The constant need for higher performance led to the development of several types of turbo-superchargers. The R.30 became the test-bed for a centrifugal supercharger built to the designs of Dipl.-Ing. W. G. Noack by Brown-Boveri & Co. of Mannheim. A 120 h.p. Mercedes D.II engine, located behind the starboard pilot, drove the supercharger which provided air to the carburetters via conduits passing internally through the wing and into the nacelles. In September 1918 the R.30 was also equipped with Helix adjustable-pitch propellers designed by Prof. H. J. Reissner. The pitch could be adjusted in flight by means of slotted cams that turned the metal sleeves into which the wooden propeller blades were fitted. The modified R.30 made its first test flight on 23 March 1918 and on 24 April attained an altitude of 19,357 feet, a remarkable improvement over the 12,500 foot ceiling of standard R.VI machines. The maximum speed was raised to 160 km.h., an increase of 30 km.h. over standard machines.

On 24 May 1918 the R.30 was performing some tests for Idflieg over Berlin. Hptm. Krupp and Lt. Offermann were at the controls; Dipl.-Ing Noack and five other crew members were also aboard. At 3300 metres altitude a wrist pin seized, which caused the connecting-rod to break and the piston to burst through the engine housing. This accident was later traced back to improper cooling of the crankcase oil due to modifications required by the supercharged Mercedes engine. A fire started which spread to the lower wing, but by descending rapidly it was possible to blow out these flames. However, long ribbons of fire continued to spew from the nacelle. Noack climbed over the lower wing to the burning nacelle and extinguished the blaze with a portable fire extinguisher. The R.30 landed safely.

In the early post-war period the R.30 was used for civil work with the name "Fletcher's World" painted on each side of the nose and rear fuselage.

R.31. Staaken built. Four 260 h.p. Mercedes D.IVa engines. Accepted January 1918. Operational with Rfa 500. Crashed in flames at Beugny 15/16 September 1918, as a result of enemy action. The British RAF War Diary has the following statement concerning the loss of the R.31. "Lt. S. C. Broome, 151 Squadron, saw a giant enemy machine held in our searchlights which he attacked firing 500 rounds altogether. The enemy aircraft burst into flames and fell on our side of the lines." Seeing that the aircraft was on fire, the commander, Lt. Wohlgemuht, ran through the aircraft and ordered the crew to bail out. Of the nine, only Lt. Wohlgemuht and one other person were saved by parachute.

R.32. Staaken built. Four 245 h.p. Maybach Mb.IVa engines. Acceptance flight on 24 January 1918. Delivered to Rfa 501 on 2 April 1918. Crash-landed in fog at Scheldewindeke and was destroyed when its bombs exploded 9/10 May 1918.

R.33. Aviatik built. Four 260 h.p. Mercedes D.IVa engines. Accepted October 1917. Operational with Rfa 501. Crashed 15 October 1918.

R.34. Aviatik built. Four 260 h.p. Mercedes D.IVa engines. Completed December 1917. At Altenburg airfield in January 1918 awaiting delivery to Front. Operational with Rfa 501. Crashed near the Front on 21 April 1918, possibly as a result of enemy action. Seven crew killed. Commanded by Oblt. Leistner.

R.35. Aviatik built. Four 260 h.p. Mercedes D.IVa engines. Acceptance flight on 26 February 1918. Flown to Staaken to be fitted with turbo-supercharger. First test flights in June–July 1918. Weight increased to 9300 kg. empty and 12,875 kg. loaded. Further details are lacking.

R.36. Albatros built. Four 260 h.p. Mercedes D.IVa engines. R.36 "several weeks away from completion" on 9 July 1917. Accepted in October 1917. Operational with Rfa 501 and believed dismantled after emergency landing on 7/8 March 1918.

R.37. Albatros built. Initially four 260 h.p. Mercedes D.IVa engines. Acceptance flight on 3 February 1918. In March 1918 radio-telephone experiments were conducted between a ground station and the R.37. Clear transmission of words, numbers and music was attained over a

distance of 30 km. using a 500 watt transmission tube. R.37 trailed a 100 metre antenna. In April 1918 Schütte-Lanz installed four 245 h.p. Maybach Mb.IVa engines. Flew to Rfa 500 on 28 May 1918. Forced to land near Betz after hit by French anti-aircraft fire 1/2 June 1918. R.37 was returning from raid on Paris in company with another R-plane. Burned but not fully destroyed by crew, who escaped (later captured?). Subject to widespread attention by Allied Press at the first R-plane to be inspected by the Allies.

R.38. Albatros built. Four 260 h.p. Mercedes D.IVa engines. Accepted 27 March 1918. After losing course over Ruhr on delivery flight from Döberitz to Cologne to join Rfa 500, it crashed on an attempted emergency landing at Heisingen on 6 May 1918.

R.39. Staaken built. Four 245 h.p. Maybach Mb.IVa engines. Completed 18 July 1917. Accepted 9 August 1917. Operational with Rfa 501. Crew consisted of Hptm. von Bentivegni commander and squadron leader; Lt. Frhr. von Lenz, first pilot, Lt. Buth, second pilot; Unteroffiziere Matern and Walter, engine mechanics; Klickermann, wireless operator; W. Teichert, machine-gunner and a fuel attendant (name lacking).

The greatest total bombs carried by any R-plane during its operational career is unknown, but the R.39 was probably champion, having dropped a total of 26,000 kg. in twenty bombing raids as painted on the nose of the machine after the war.[1]

28 or 29 September 1917	Sheerness	26 May 1918	Abbeville
6 December 1917	Margate	28 May 1918	Abbeville
25 December 1917	Boulogne	31 May 1918	Etaples
28 or 29 January 1918	London	30 June 1918	Amiens
16 February 1918	London	11 July 1918	Doullens
7 March 1918	London	13 July 1918	Arras
1 April 1918	Boulogne	15 July 1918	Rouen
21 April 1918	St. Omer	16 August 1918	Rouen
9 May 1918	Dover	24 August 1918	Gravelines
19 May 1918	Chelmsford	22 (?) 1918	Poperinghe

The only three 1000 kg. bombs dropped on England were carried by the R.39.

R.52. Aviatik built. Initially four 300 h.p. Basse & Selve BuS.IVa engines. Completed May 1918. Ground tests on 7 May 1918 showed Basse & Selve engines not fully reliable. Four 245 Maybach Mb.IVa engines were installed. Acceptance flight on 5 June 1918. Delivered to Rfa 500 on 20 June 1918 with acceptance guaranteed on 28 June provided certain defects were corrected. At least one, but possibly all, of the second Aviatik-built R.VI series had modified fuselages. The cockpit was raised, moved farther to the rear and remained open. The front gun position was raised to the level of the upper longerons. Operational with Rfa 500. Crashed and burned on 11/12 August 1918 at Villers la Tour. Hptm. Erich Schilling and four members of the crew perished in the crash.

R.53. Aviatik built. Four 245 h.p. Maybach Mb.IVa engines. Completed July 1918. Assigned to Rea Cologne as trainer, owing to insufficient performance, September 1918.

R.54. Aviatik built. Four 245 h.p. Maybach Mb.IVa engines. Expected delivery in October 1918 pending decision whether to install a fifth Maybach engine in the nose. Probably never completed and scrapped in 1919.

[1] For some reason this list did not tally with official records. The raid of 22/23 December 1917, during which the R.39 bombed the Thames estuary, is not included, possibly because it was not a success. According to available records, the R.39 bombed Dunkirk (the alternate target) instead of Dover (the intended target) on 9 May 1918.

SPECIFICATIONS

Type:	Staaken R.VI
Manufacturer:	Flugzeugwerft G.m.b.H., Staaken, Berlin
Engines:	Four 260 h.p. Mercedes D.IVa engines
Dimensions:	Span, 42·2 m. (138 ft. 5½ in.)
	Chord inner, 4·6 m. (15 ft. 1 in.)
	Chord outer, 3·6 m. (11 ft. 10 in.)
	Gap inner, 4·6 m. (15 ft. 1 in.)
	Gap outer, 3·8 m. (12 ft. 5½ in.)
	Incidence inner, 3½ degrees
	Incidence outer, 2 degrees
	Dihedral upper, none
	Dihedral lower, 1½ degrees
	Back stagger, 0·4 m. (1 ft. 3½ in.)
	Length, 22·1 m. (72 ft. 6 in.)
	Height, 6·3 m. (20 ft. 8 in.)
	Tail span, 9·0 m. (29 ft. 6 in.)
	gap, 2·0 m. (6 ft. 6½ in.)
	Propeller centres, 8·0 m. (26 ft. 3 in.)
	Tractor propellers diameter, 4·26 m. (14 ft.)
	Pusher propeller diameter, 4·3 m. (14 ft. 1 in.)
	Wheel diameter, 1·02 m. (3 ft. 4 in.)
Areas:	Wings, 332 sq. m. (3572 sq. ft.)

Weights:	Wings,	2,050 kg.	
	Fuselage,	1,450 kg.	
	Tail unit,	400 kg.	
Weights:	Undercarriage,	800 kg.	
	Accessories,	250 kg.	
	Engines and transmission,	2,730 kg.	
	Empty,	7,680 kg.	(16,934 lb.)
	Fuel,	1,980 kg.	(4,366 lb.)
	Disposable load,	1,800 kg.	(3,969 lb.)
	Loaded,	11,460 kg.	(25,269 lb.)

Wing Loading:	34·5 kg./sq. m. (7·1 lb./sq. ft.)
Performance:	Maximum speed, 130 km.h. (80·8 m.p.h.)
	Climb, 1000 m. (3281 ft.) in 11 mins.
	2000 m. (6562 ft.) in 27 mins.
	3000 m. (9843 ft.) in 55 mins.
	Ceiling, 3800 m. (12,467 ft.) in 150 mins.
	Duration, 7–8 hrs.
Fuel:	2115 litres (465 Imp. Gals.)
Armament:	Provision for nose, dorsal, ventral and upper-wing machine-gun positions
Service Use:	Western Front with Rfa 500 and Rfa 501, 1917–November 1918

SPECIFICATIONS

Type:	Staaken R.VI
Manufacturer:	Flugzeugwerft G.m.b.H., Staaken, Berlin
Engines:	Four 245 h.p. Maybach Mb.IVa engines
Dimensions:	Span, 42·2 m. (138 ft. 5½ in.)
	Length, 22·1 m. (72 ft. 6 in.)
	Height, 6·3 m. (20 ft. 8 in.)
	(Other dimensions same as Mercedes-powered R.VI)
Areas:	Wings, 332 sq. m. (3572 sq. ft.)
Weights:	Empty, 7921 kg. (17,465 lb.)
	Loaded, 11,848 kg. (26,125 lb.)
Wing Loading:	35·7 kg./sq. m. (7·3 lb./sq. ft.)
Performance:	Maximum speed, 135 km.h. (83·9 m.p.h.)
	Climb, 1000 m. (3281 ft.) in 10 mins.
	2000 m. (6562 ft.) in 23 mins.
	3000 m. (9843 ft.) in 43 mins.
	Ceiling, 4320 m. (14,174 ft.) in 146 mins.
	Duration, 7–10 hrs.
Fuel:	3000 litres (660 Imp. Gals.)
Armament:	Provision for nose, dorsal, ventral and upper-wing machine-gun positions
Service Use:	Western Front with Rfa 500 and Rfa 501, 1917–November 1918

SPECIFICATIONS

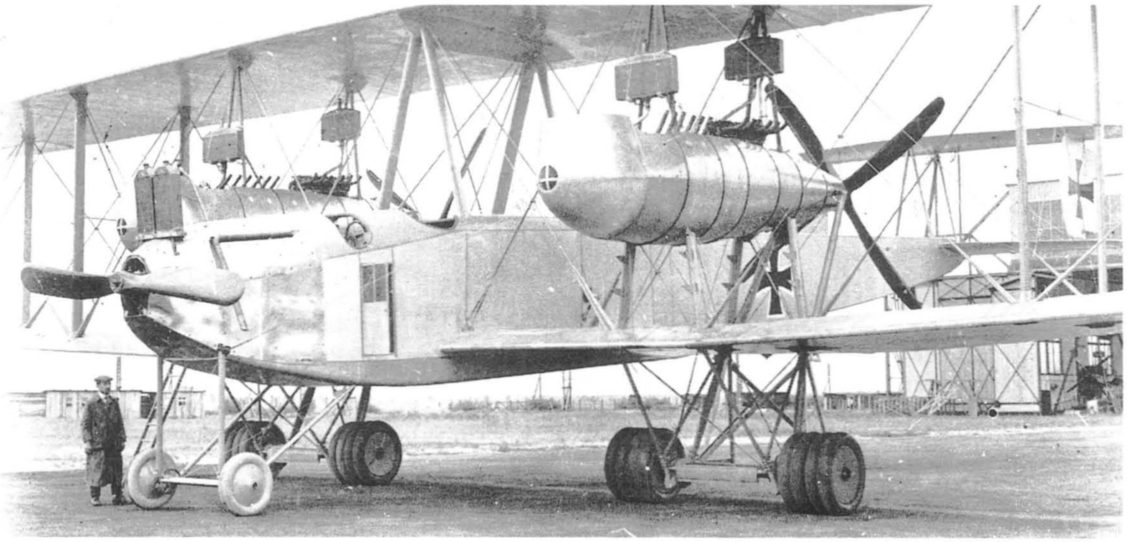
Type:	Staaken R.VI 30/16
Manufacturer:	Flugzeugwerft G.m.b.H., Staaken, Berlin
Engines:	Four 260 h.p. Mercedes D.VIa engines
	One 120 h.p. Mercedes D.II to drive Brown–Boveri supercharger
Dimensions:	Span, 42·2 m. (138 ft. 5½ in.)
	Length, 22·1 m. (72 ft. 6 in.)
	Height, 6·3 m. (20 ft. 8 in.)
	Propeller diameters, 4·5 m. (14 ft. 9 in.)
	(Other dimensions same as Mercedes-powered R.VI)
Areas:	Wings, 332 sq. m. (3572 sq. ft.)
Weights:	Empty, 8600 kg. (18,963 lb.)
	Loaded, 11,590 kg. (25,556 lb.)
Wing Loading:	35·0 kg./sq. m. (7·2 lb./sq. ft.)
Performance:	Maximum speed, 160 km.h. (99·4 m.p.h.)
	Climb, 1000 m. (3281 ft.) in 10 mins.
	2000 m. (6562 ft.) in 24 mins.
	3000 m. (9843 ft.) in 35 mins.
	Ceiling, 5900 m. (19,357 ft.) in 102 mins.
Service Use:	None

Staaken R.VII

The Staaken R.VII would appear on the imaginary Staaken family tree as a direct-line descendant of the earlier R.IV. There is little doubt that the R.VII was built to capitalize on the success experienced with the R.IV configuration. The R.VII employed the same engines and drive system, but differed very slightly from its predecessor in the following ways: upper-wing gun platforms were omitted; radiator positions were reversed; the engineer's compartment had open cockpits; the tail was a single-bay structure and the undercarriage mounted eight wheels. A more subtle but most important difference between the two aircraft was that the fuselage of the R.VII was about 4 feet shorter. The slim rear fuselage of earlier VGO–Staaken R-planes had tendency to bend and twist in flight; therefore, the length of the fuselage was reduced to increase its stiffness. All later Staaken aircraft had the shorter fuselage configuration for that reason.

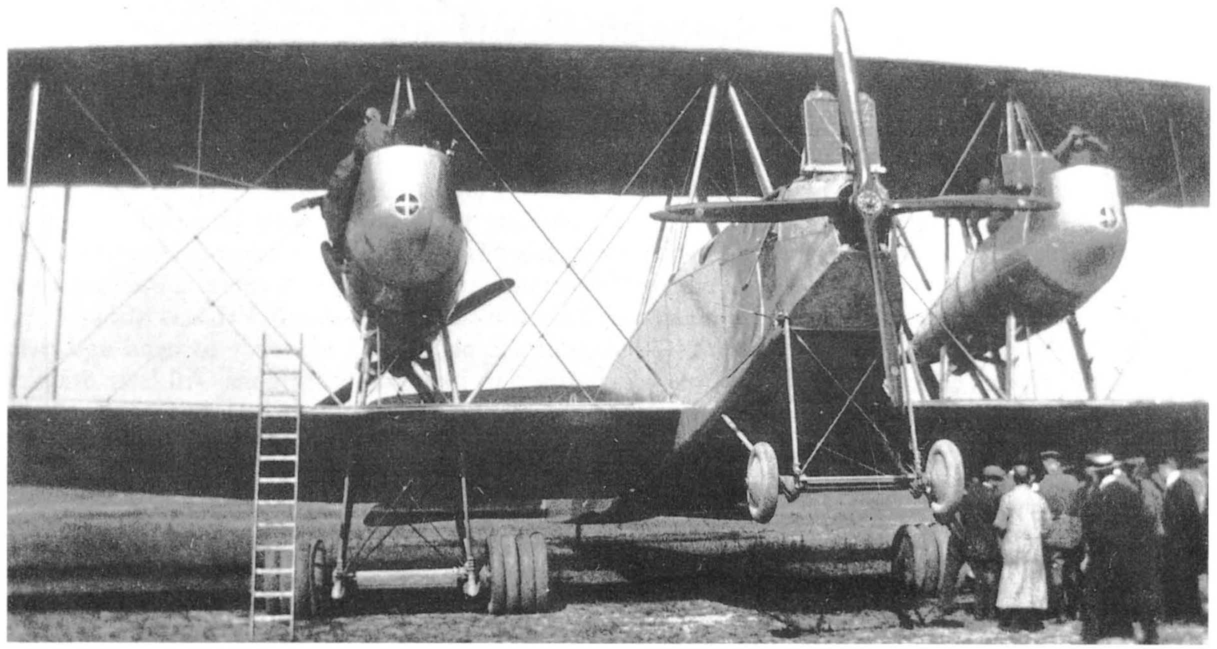
The R.VII, serial number R.14/15, was accepted on 26 June 1917 after reaching an altitude of 3800 metres in 100 minutes carrying a useful load of 3600 kg. It was delivered to Idflieg (Rea) on 3 July and assigned to Rfa 501 on 29 July 1917 after successfully completing a 6 hr. 30 min. practice mission with military load the day before. Its service life was destined to be short, for it crashed in the following month. Here is what happened according to two eye-witness reports:

On Friday, 14 August 1917 the R.VII, commanded by officers of Rfa 500, was on its way to the Front. Although Rfa 500 did not arrive at Custinne until February 1918, it is believed that advance elements of Rfa 500 may have been sent to the Front sooner, possibly to join Rfa 501 in the Ghent



Staaken R.VII 14/15.

area. It was decided to land on the airfield of Flieger Ersatzabteilung 5 (Fea 5) in Halberstadt for repairs, and an aircraft was immediately dispatched from Fea 5 to obtain replacement parts from Berlin. On Sunday, 19 August 1917 repairs were completed and the crew of nine climbed aboard to take-off before a crowd composed of city officials, off-duty soldiers and curious citizens. The R.VII headed into the wind down the airfield, at the far end of which was a low hill topped with a few tall pine trees. The Fea 5 target ranges were located on the far side of the hill, which dropped sharply into a rock-strewn ravine. At some 60–70 metres altitude the right wing seemed to drop, forcing the R.VII into a starboard turn, and it was apparent to the spectators that something was wrong with the aircraft. The facile Halberstadt trainers would have had no difficulty in swinging around to make a safe downwind landing, but the unwieldy R-plane was not capable of performing this manoeuvre quickly enough. To the anxious spectators it seemed as if the R.VII would either

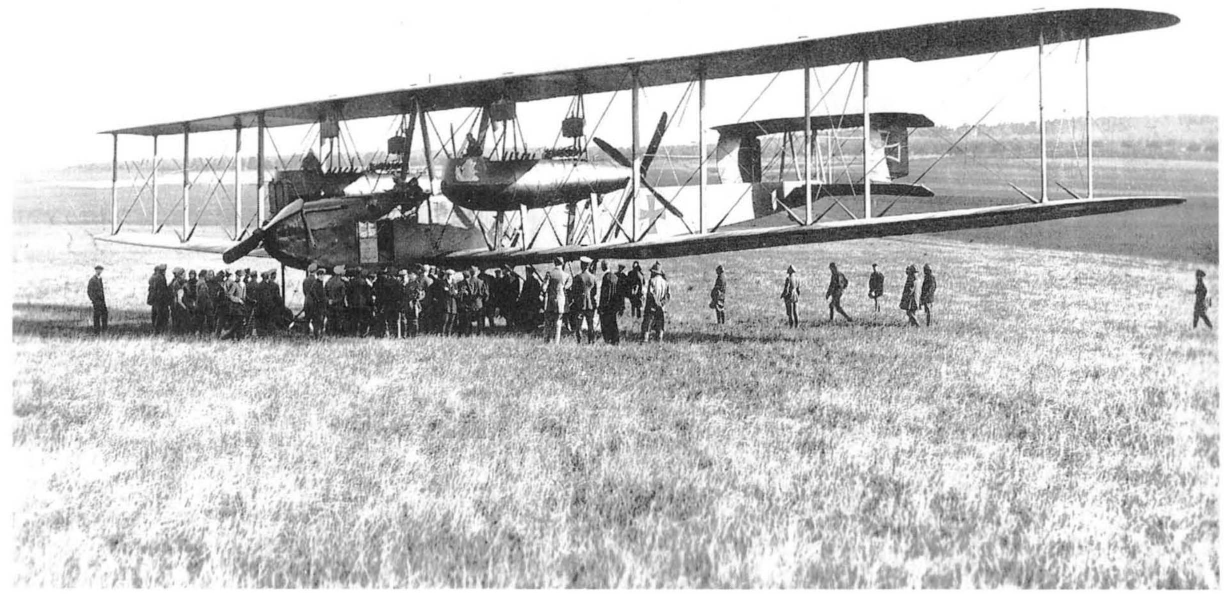


Staaken R.VII 14/15, with four-bladed tractor propeller.

clear the pines and make an emergency landing in the treacherous terrain on the far side of the hill or attempt to drop into the pine trees on the hill. The port engines were throttled back and the R.VII lost altitude, seemingly in preparation to land in the trees. For the moment, it appeared as if the exertions of the crew were going to be crowned with success after all.

Suddenly, as if the starboard engines had jerked to a stop, the right wing lurched towards the ground and hooked a pine tree. With the added thrust of the port engines, the R.VII spin in a 180 degree arc, bounced off the hill and crashed into the ravine. The horrified spectators saw a black pall of smoke slowly rise into the air.

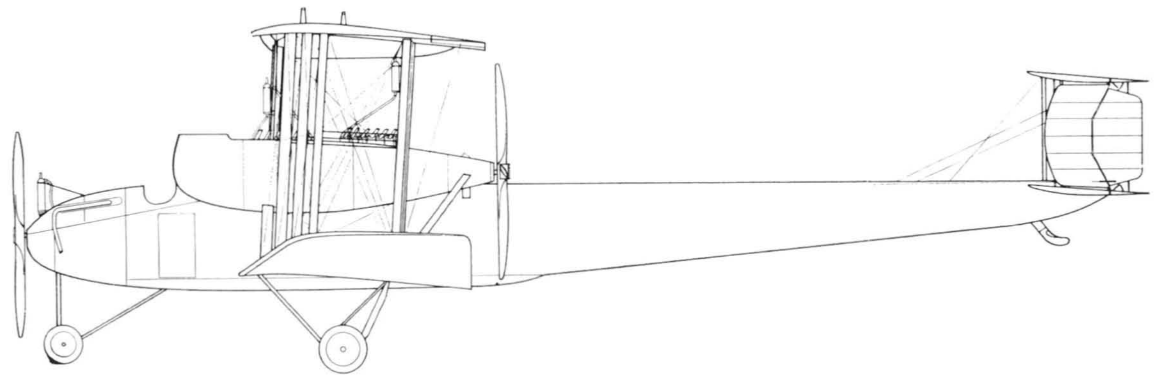
Three badly burned crew members managed to escape and the starboard nacelle mechanic, who



Staaken R.VII 14/15 photographed before the fatal take-off crash at Halberstadt.

saw the mishap coming, jumped free as the machine crashed. The wireless operator fought his way out of the flaming, twisted wreckage and a machine-gunner was pulled from the crash by an alert and brave non-commissioned officer. Six aircrew died in the crash.

What actually happened aboard the R.VII was told by the surviving flight mechanic. He stated that the replaced leather clutch facing had been cleared for flight by the aircraft's chief mechanic, who perished in the crash. Shortly after take-off the leather clutch burned through and the engine, robbed of its load and running at full speed, overheated and seized. Simultaneously, the other starboard engine, which was connected to the same gear-box, lost speed. The commander, noticing the difficulty, desperately signalled to the starboard mechanic, who interpreted the frantic hand waving as an order to shut off the engines. The surviving crew members felt the engines were cut just as the R.VII was turning back to the airfield. The starboard wing dropped, hooked the pine tree and the fate of the R.VII was sealed.



STAAKEN R.VII SERIAL No. R.14/15

Colour Scheme and Markings

The R.VII had a buff finish reminiscent of the early VGO types and carried the Patée cross insignia with white edges on wings, fuselage and tail.

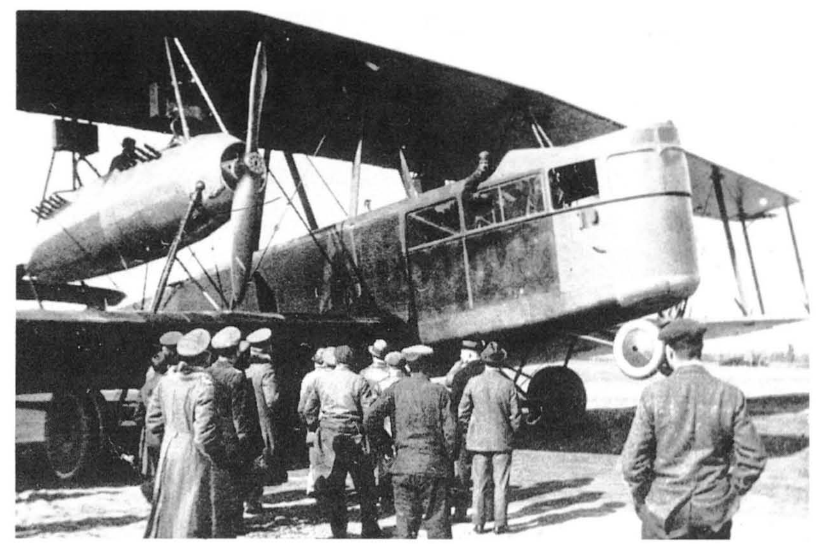
SPECIFICATIONS

Type:	Staaken R.VII	
Manufacturer:	Flugzeugwerft G.m.b.H., Staaken, Berlin	
Engines:	Two 160 h.p. Mercedes D.III engines	
	Four 220 h.p. Benz Bz.IV engines	
Dimensions:	Span, 42·2 m. (138 ft. 5½ in.)	
	Length, 22·1 m. (72 ft. 6 in.)	
	Height, 6·8 m. (22 ft. 3½ in.)	
	Tractor propeller diameter, 4·2 m. (13 ft. 9 in.)	
	Pusher propeller diameter, 4·1 m. (13 ft. 6 in.)	
Areas:	Wings, 332 sq. m. (3572 sq. ft.)	
Weights:	Wings,	2,350 kg.
	Fuselage,	1,450 kg.
	Tail unit,	400 kg.
	Accessories,	250 kg.
	Undercarriage,	900 kg.
	Engines and transmissions,	3,573 kg.
	Empty,	8,923 kg. (19,675 lb.)
	Fuel,	2,140 kg. (4,719 lb.)
	Disposable load,	1,890 kg. (4,167 lb.)
	Loaded,	12,953 kg. (28,561 lb.)
Wing Loading:	39·0 kg./sq. m. (8·0 lb./sq. ft.)	
Performance:	Maximum speed, 130 km.h. (80·9 m.p.h.)	
	Climb, 1000 m. (2381 ft.) in 12 mins.	
	2000 m. (6562 ft.) in 25·5 mins.	
	3000 m. (9843 ft.) in 50 mins.	
	Ceiling, 3850 m. (12,631 ft.)	
Fuel:	3140 litres (691 Imp. Gals.) in twelve 245 litre tanks	
	Gravity tank, 155 litres (34·1 Imp. Gals.)	
	Oil, 171 litres (37·6 Imp. Gals.)	
Service Use:	None	

Staaken R.XIV

In late 1917 the Staaken R.VI was followed by an improved, more powerful version, designated the Staaken R.XIV. These aircraft were powered by four 350 h.p. Austro-Daimler twelve cylinder engines, the most powerful available at the time. Unfortunately, the Austro-Daimler engine proved unreliable and the hope of developing a "super" R.VI series was shattered.

The R.43/17, first of the new R.XIV series, was almost complete in February 1918. A March 1918 Idflieg status report stated that this aircraft had a new seating arrangement for the pilots, consisting of an open cockpit on the upper fuselage decking to provide a broad field of view. It also provided an unencumbered commander's bomb aiming position in the nose. The engines were installed without reduction gears in order to obtain full-scale performance comparison with geared propellers on other R-planes, and the engine mount was redesigned to eliminate the recurrent failure of engine support struts on the R.VI series. By March the R.43 had already flown many times. Its first flight in the acceptance programme took place on 11 April 1918, on which the R.43 carried a 4020 kg. useful load to 3100 metres altitude in 91 minutes. Soon after taking-off on the next day a connecting-rod broke in one of the rear engines. The Austro-Daimlers were replaced by four 300 h.p. Basse & Selve BuS.IVa engines, and was reported once more ready for flight testing on 10 May 1918. However, the new unproven BuS.IVa engines showed a propensity for piston seizure and were in their turn removed from both the R.43 and the R.44 (which had been expected to make its first flight on 3 May 1918). The final installation consisted of five 245 h.p. high-compression Maybach Mb.IVa engines. Since the R.XIV weighed some 2000 kg. more than the R.VI, an additional engine mounted in the nose was necessary to at least keep performance on a par with the R.VI.



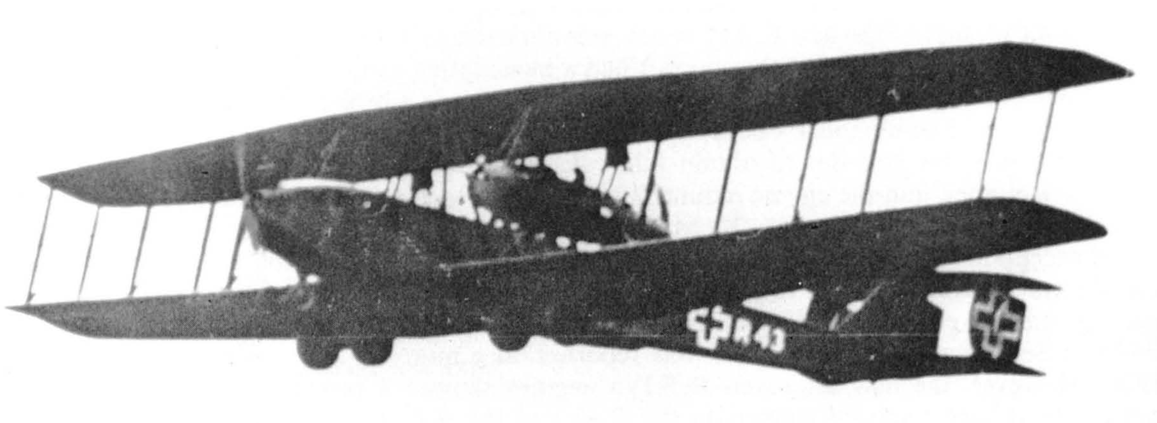
Staaken R.XIV 43/17 in its original form with four Austro-Daimler engines arranged similarly to the R.VI.

It required some two months to modify the fuselage to mount the fifth engine. According to the records, the R.43 was ready for acceptance in July and the R.44 and R.45 were ready for their first flights on 3 July and 10 July 1918 respectively. The R.44 was delivered in August and the R.45 in July 1918. These two machines differed from the R.43 in that the nacelle tractor propellers were driven directly by the engines without benefit of the usual reduction gears.

In his writings after the war, von Bentivegni, the experienced commander of Rfa 501, regretted the fact that no systematic attempt had been made to improve the performance of Staaken R-planes by carefully refining the R.VI series. Instead of concentrating on weight reduction and streamlining,

newer machines such as the R.XIV embodied a purposeless increase of fuselage size, weight and drag, which in themselves taxed performance and to some extent nullified the effect of an additional engine.

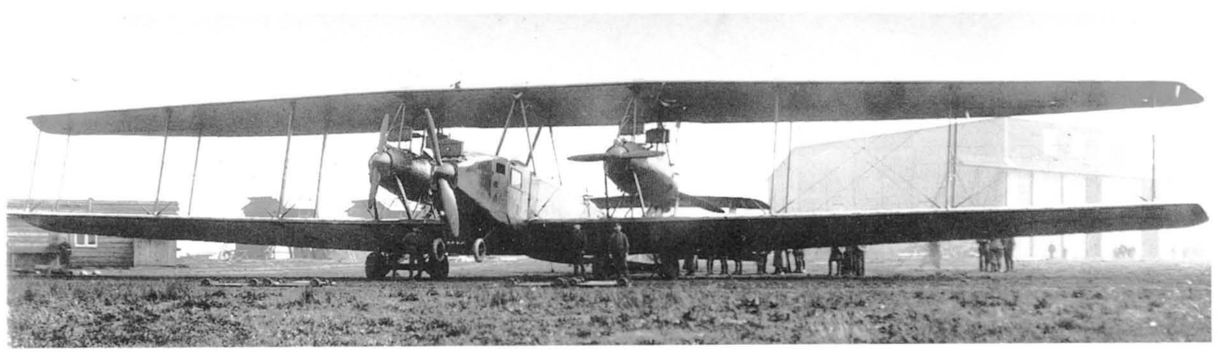
On the other hand, after comparing his experiences with both four- and five-engined Staaken R-planes, von Bentivegni was convinced that the disadvantages of the nose engine had been over-emphasized and its advantages minimized. It should never be forgotten, he said in 1920, that an



Staaken R.XIV 43/17 powered by five Maybach Mb.IVa engines.

additional engine offered increased reliability, the most important factor in R-plane design. The problem of the high landing gear, which had been responsible for the elimination of the nose engine in the first place, was solved by simply keeping it short. This was made possible by design changes which allowed a normal "tail-down" ground attitude.

Among the disadvantages discussed by von Bentivegni was the proximity of the fuselage engine to the main fuel tanks, a factor that increased the fire hazard in event of a crash. It was his opinion, however, that this danger was more than compensated for by the increased reliability provided by the



Staaken R.XIV.

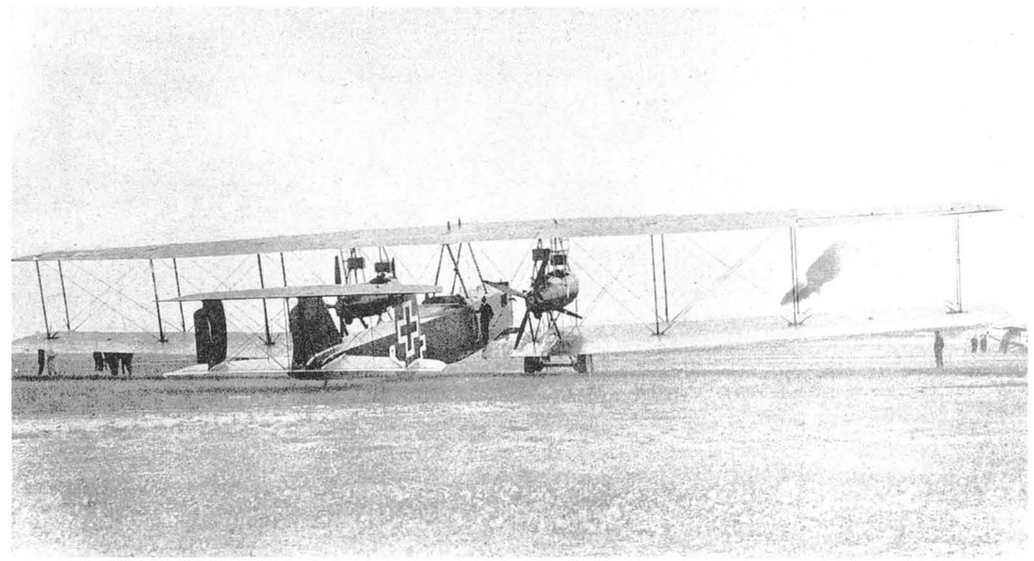
additional engine. An unexpected problem discovered during operational service was that of unavoidable vibrations of the nose engine. These vibrations had a very deleterious effect on the more delicate instruments installed in the later Staaken machines, particularly on sensitive electric wiring and connections.

According to von Bentivegni, the efficiency of the small-diameter ungeared propellers was hopelessly inadequate, and he considered this modification a total failure. Furthermore, the R.XIV series had strengthened airframes to house the more powerful Austro-Daimler engines. The resultant

increase in weight was yet another factor which lowered the performance of these machines. Not until the last months of the war were R.XIV shortcomings eliminated with the advent of the improved R.XIVa series.

The typical Staaken wing was retained on the R.XIV with exception of a 1·5 degree sweepback of the outer wing panels; a trailing edge cut-out above the propellers and the fitting of balanced ailerons which were neatly faired into the wingtip outline. Upper-wing gun positions were installed slightly outboard of the nacelles and between the nacelle struts rather than behind as in the R.VI.

The nacelles, somewhat slimmer than those on the R.VI, were mounted higher in the wing gap, and the nacelle strut arrangement was considerably modified. The R.XIV machines were generally fitted with propeller spinners. The R.45 was at one time equipped with large-diameter four-bladed pusher propellers, whose blades were unusually narrow. The large spinner of the nose engine and the aluminium engine cowling provided a smooth entry to the fuselage, broken only by the protruding radiator and the auxiliary landing gear.



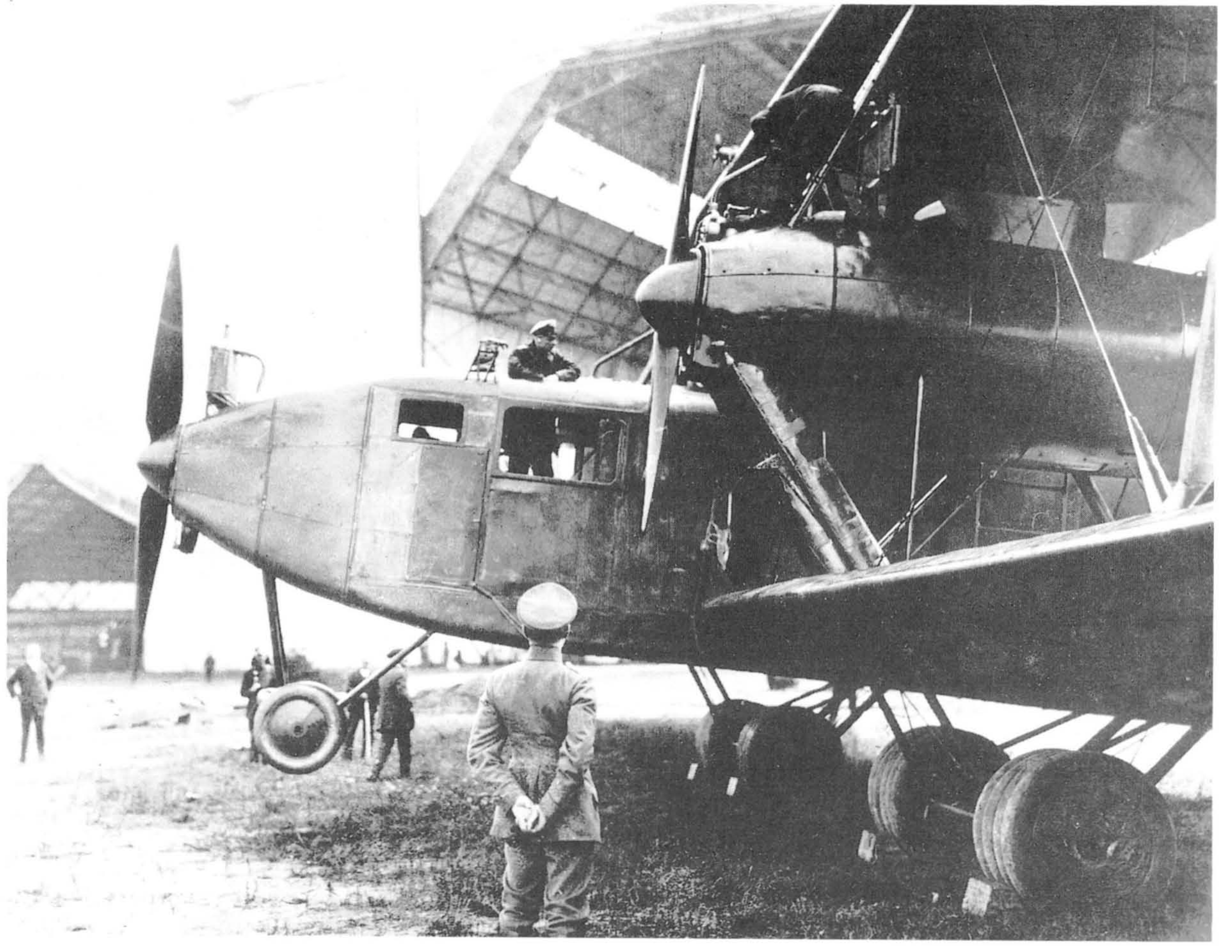
Staaken R.XIV 45/17 with the pilot's cockpit placed behind the wings.

As in the earlier Staaken giants, the flight engineer's compartment was located directly behind the nose, followed by the enclosed navigation and commander's cabin, which also contained the bomb-aiming apparatus that may have been hung externally during use. Then came the large open pilots' cockpit located in the upper decking. The open cockpit was a definite departure from the closed cockpit of the R.VI and demonstrated the crews' preference to fly in "open air" unhampered by window reflection, dazzle and condensation and the strange feeling of being shut in from the rushing air.

By this time the Germans had tested and perfected a parachute that was being issued to service aircrews as it became available. The R.XIV carried a full complement of parachutes stored in external fuselage compartments with short "hook-up" lines running to each of the crew stations.

The armament carried by the R.XIV consisted of six machine-guns distributed as follows: one each in the upper-wing gun positions and two each in the dorsal and ventral positions. The increase in the number of machine-guns over the R.VI, which generally carried four (sometimes five) guns, was a reflection of the intensified night-fighter activity of the Allies.

A novel optical communication system developed by the Karl Bamberg firm was tested on the R.44. The technique consisted of writing a message on a frosted glass and then projecting the image

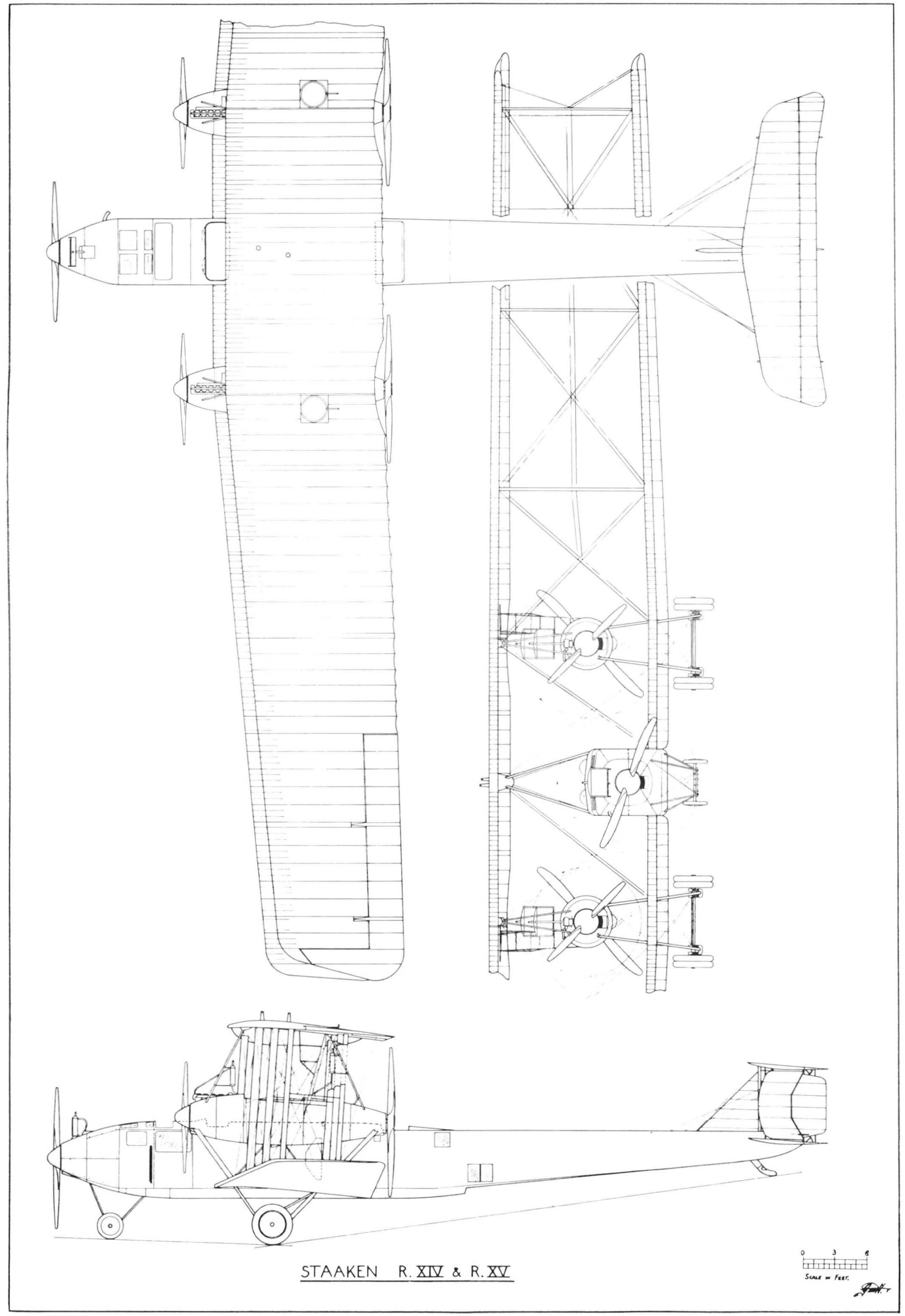


Staaken R.XIV.

through prisms and lenses on to an opaque remote-reading surface. The device worked well on the ground, but failed under vibration, which blurred the message to illegibility.

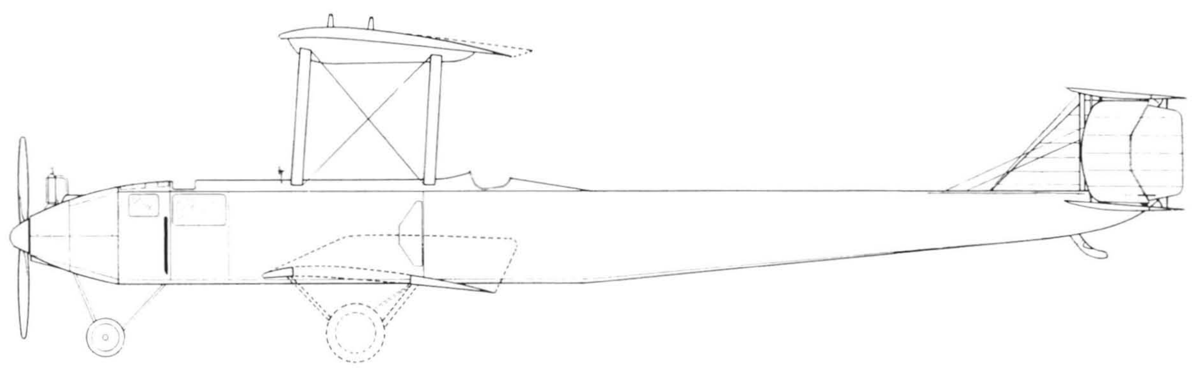
The R.45 was fitted with a cockpit located behind the trailing edge of the wings in a manner similar to the AEG R.I. The purpose of this configuration was to provide a better view of the undercarriage and ground while landing. During tests at Staaken the wing-root panels were left open in order to improve the downward view. By the time the R.45 left for the Front these panels had been covered and the narrow chord four-bladed propellers replaced by the more usual two-bladed propellers.

On 9 August 1918 the R.45 left Staaken for Hanover, and on the next day continued to the Rfa 500 airfield at Morville. Lt. von Plötz and Lt. Steinhauser were the officers aboard R.45 when, accompanied by R.31, it took-off to bomb le Havre on 15 September 1918. After the raid, the R.45 received a wireless message warning it not to return to Morville because enemy aircraft were over the airfield and the landing lights would not be turned on. But the fuel supply was too low to continue on, forcing the commander to make the decision to land. The wireless operator notified the airfield and asked that ground personnel signal with flashlights. The first and second landing attempts failed, and it was not until a number of flares had been shot-off that enough illumination was provided to enable the pilots to touch down on the airfield. In spite of the emergency illumination, the R.45 missed the runway, which the crew noticed by the severe shaking they received. Suddenly, in the darkness, the left wing struck an obstruction, then the right wing and the R.45 stood still. In the morning the damage was inspected and it was found that the left wing had hit a water-tank wagon and a large portable ladder; the right wing some construction material and the roof of a peasant house. This fortunate accident saved the



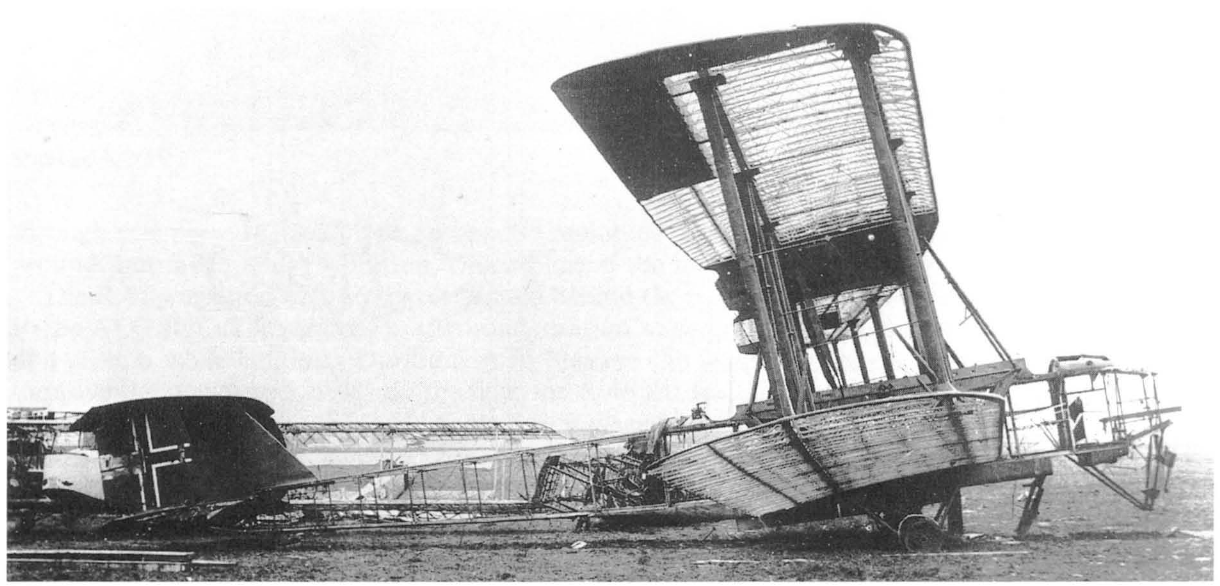
lives of sixty men who were sleeping in a barracks directly in the path of the careering bomber. It is doubtful if the R.45 was repaired in time to participate in further bombing raids before the Armistice.

The R.43 and R.44 also saw service on the Western Front during the autumn of 1918. The R.43 has been remembered as one of two R-planes confirmed as shot down by an opposing



STAAKEN R.XIV SERIAL No. R.45. EXPERIMENTAL RE-LOCATION OF THE CONTROL POSITION.

aircraft. On the night of 10/11 August 1918 the R.43 of Rfa 501 was on a bombing mission when it was lit up by searchlights over Talmas. According to the records, it was an easy target due to the large amount of exhaust smoke. The heavy concentration of lights attracted four British pilots to the scene, one of whom was Capt. A. B. Yuille of 151 Squadron R.A.F. Recently



Wreckage of the Staaken R.44 on the Cologne airfield, February 1919.

transferred to France from Home Defence duties in England, 151 Squadron was a special night-fighter unit flying Sopwith Camels. The R.43 was attacked from all sides. Yuille closed to about 25 yards, but did not fire a shot until he had settled well below and behind the bomber's tail. Yuille then opened with three short bursts and put one engine out of action. The next two bursts set the fuselage afire around the rear gunner's cockpit. The R.43 started going down, with its nose down and turning on one side. It then dived more steeply, burst into flames and one set of wings dropped off. Yuille followed the burning mass down and watched it crash. The bomber's

fall was seen for miles, even by pilots who were bombing 15 miles away and on the German side of the lines. Five of the crew attempted to bail out, but all seven crew members were killed.

On hitting the ground, one of the bombs exploded, completely wrecking the fuselage. French and British aviation experts scrutinized the remains carefully, finding, surprisingly enough, two Lewis machine-guns (and also two Parabellum) in the wreckage. An interesting British Intelligence comment that "little regard was paid to saving weight in the design of fittings throughout the machine, some fittings being more than ordinarily heavy and cumbersome, even for such a large machine", supports von Bentivegni's comments as noted earlier.

On 11 February 1919 British forces occupying the Rhineland found the R.44 abandoned on the airfield at Cologne. The machine had been stripped of fabric and engines, and only the gaunt skeleton remained.

As a sideline to this history, it should be noted that just prior to the delivery of the last Zeppelin airship built at Staaken (the L.64), the name of the Zeppelin concern was changed again. On 25 January 1918 the Luftschiffbau Zeppelin G.m.b.H. and the Flugzeugwerft G.m.b.H. merged to become the Zeppelin-Werke G.m.b.H. Contemporary photos show cavernous airship hangars serving as construction and assembly areas for Staaken R-planes.

Colour Scheme and Markings

The R.XIV machines were finished overall in printed camouflage fabric. The standard Latin cross was carried on wings, fuselage and tail. The serial numbers were painted in large white figures on the rear fuselage section.

SPECIFICATIONS

Type:	Staaken R.XIV
Manufacturer:	Zeppelin-Werke G.m.b.H., Staaken, Berlin
Engines:	Five 245 h.p. Maybach Mb.IVa engines
Dimensions:	Span, 42·2 m. (138 ft. 5½ in.)
	Chord inner, 4·6 m. (15 ft. 1 in.)
	Chord outer, 3·6 m. (11 ft. 10 in.)
	Gap maximum, 4·6 m. (15 ft. 1 in.)
	Gap minimum, 3·8 m. (12 ft. 5½ in.)
	Dihedral upper, none
	Dihedral lower, 2 degrees
	Sweepback, 1½ degrees
	Incidence inner, 3½ degrees
	Incidence outer, 1 degree
	Length, 22·5 m. (73 ft. 10 in.)
	Height, 6·3 m. (20 ft. 8 in.)
	Tractor propeller diameter, 4·1 m. (13 ft. 5½ in.)
	Nacelle tractor propeller diameter, 3·25 m. (10 ft. 7½ in.)
	Nacelle pusher propeller diameter, 4·3 m. (14 ft. 1 in.)
	Wheel diameter, 1·3 m. (4 ft. 3 in.)
Areas:	Wings, 334 sq. m. (3594 sq. ft.)
Weights:	Empty, 10,350 kg. (22,822 lb.)
	Loaded, 14,450 kg. (31,862 lb.)
Performance:	Maximum speed, 130 km.h. (80·8 m.p.h.)
	Climbing speed, 100 km.h. (62·1 m.p.h.)
	Climb with load, 3000 m. (9843 ft.) in 70 mins.
	Ceiling, 3700 m. (12,140 ft.)
	Range with 1000 kg. bombs, 1300 km. (808 miles)
Fuel:	3150 litres (693 Imp. Gals.)
Armament:	Provision for dorsal, ventral and two upper-wing machine-gun positions
Service Use:	Western Front with Rfa 500 and Rfa 501 August–November 1918

Staaken R.XIVa

The Staaken R.XIVa series comprised the last R-planes to be built by Staaken during the war. These aircraft were delivered later than the Staaken R.XV series.

The R.XIVa, as the designation indicates, was an improved version of the R.XIV, modified to increase its rate of climb and operating ceiling with increased war load. To achieve this end, reduction gearing was again fitted to all engines and the weight of the machine was considerably reduced by internal structural changes and removal of upper-wing gun mounts and the bomb-bay fairing. The dimensions of the fuselage and nacelles were reduced, which resulted in a small increase of speed.

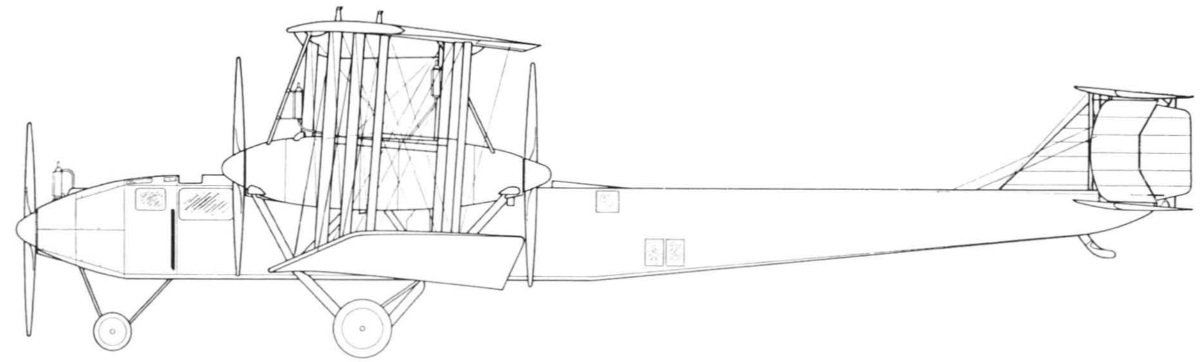
Staaken R.XIVa 69/18 with a visiting Argentine commission at Döberitz.

The only other obvious change was that the elevator surfaces were balanced, making the R.XIVa the first Staaken machine to have all its control surfaces balanced.

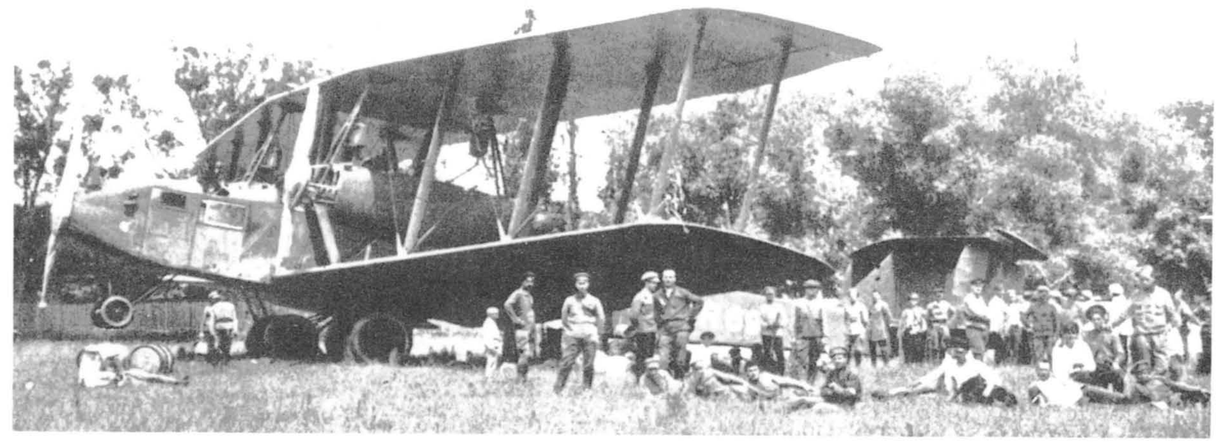
Idflieg ordered four R.XIVa machines from Staaken, and these received the serial numbers R.69 to R.72. Due to the production programme it was not possible to include all the modifications, particularly weight reduction, on the R.69; however, the R.70 was to be a fully lightened version. The R.69, delivered on 19 October 1918, did not see any front-line service. The R.70 and 71 were probably completed in late 1918 or early 1919, and it is not known if the R.72 was finished.

In 1919 the R.69 was chartered by the Ukrainian Government to fly money into the Ukraine, and was seized by the Inter-Allied Control Commission when it landed on a return flight at Aspern near Vienna. It was subsequently turned over to Italian authorities. The R.70 and R.71 were also flown between Germany and the Ukraine to deliver currency. On 19 September 1919 the R.70 was confiscated by the Roumanian Government when it made a forced landing in Bessarabia. The R.71 crashed and burned of unknown causes in the forest of Ratibor during the summer of 1919.

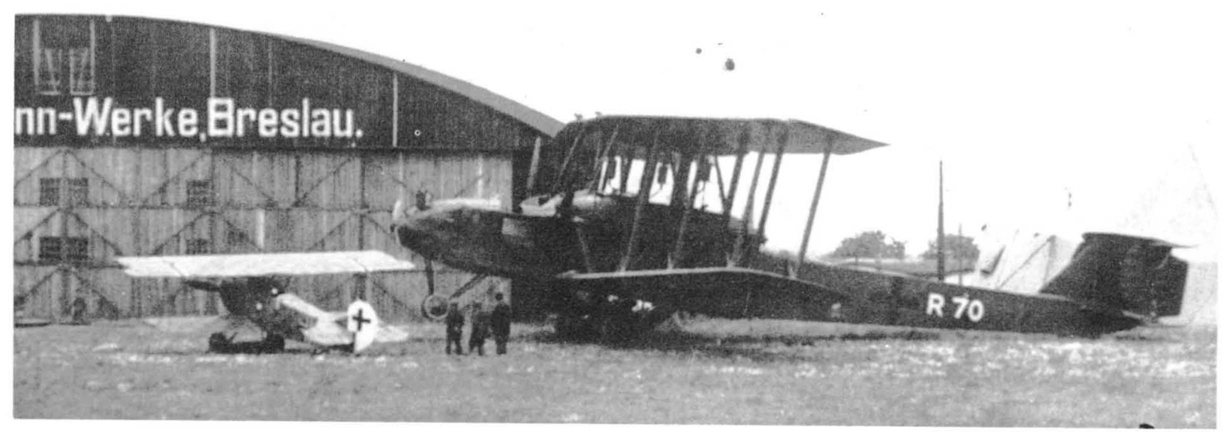
Schütte-Lanz was also given a contract to build three RXIVa machines numbered R.84 to R.86 at the cost of 600,000 marks each, but none were completed prior to the end of the war. Further details may be found in the Schütte-Lanz chapter.



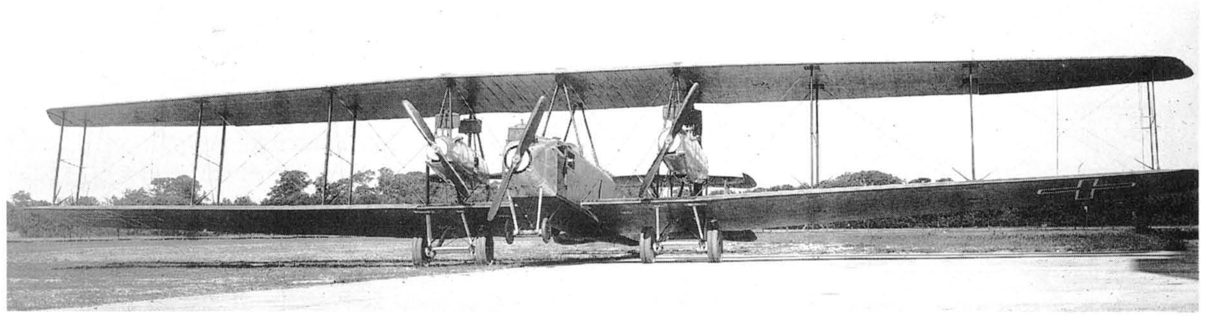
STAAKEN R. XIV A. SERIAL No. R.69 TO R.72



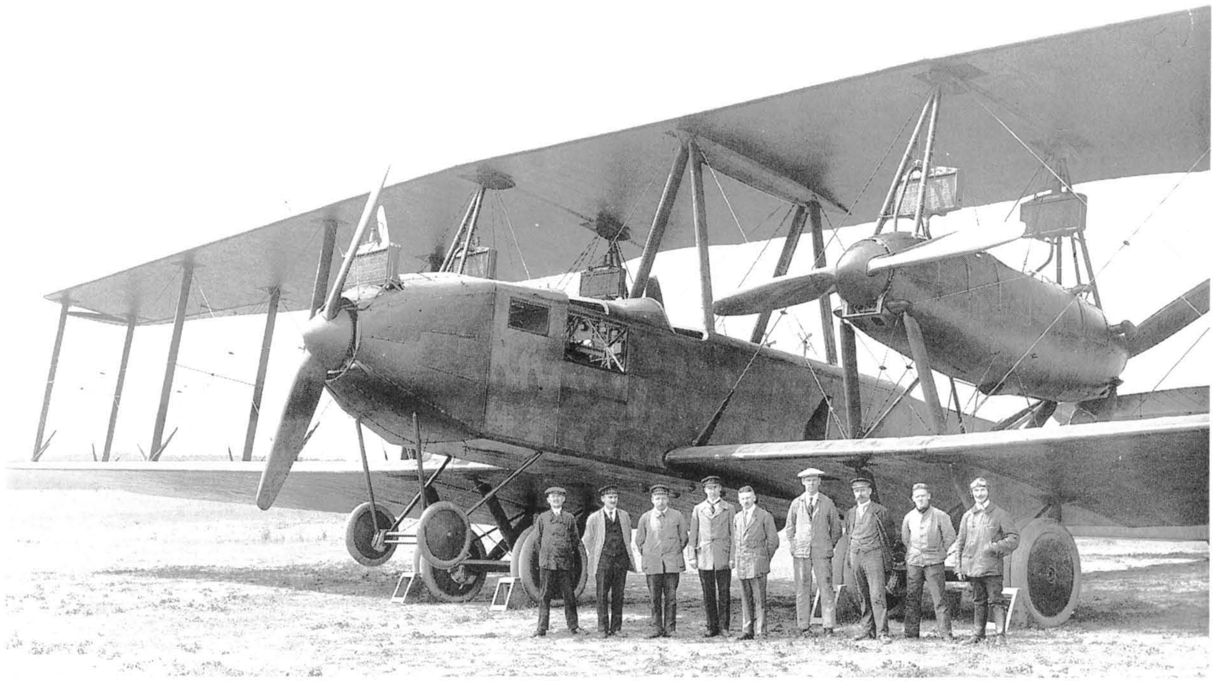
Staaken R.XIVa 69/18 in the Ukraine.



Staaken R.XIVa 70/18 on the Hundsfeld airfield near Breslau.



Staaken R.XIVa (Schül) 84/18 prior to the fitting of propeller spinners.



The completed Staaken R.XIVa (Schül) 84/18.

Colour Scheme and Markings

The R.XIVa machines were finished overall in printed camouflage fabric. The standard Latin cross was carried on wings, fuselage and tail. The serial numbers were painted in large white figures on the rear fuselage section. These machines continued to carry the Latin cross during their post-war operations.

SPECIFICATIONS

Type:	Staaken R.XIVa
Manufacturer:	Zeppelin-Werke G.m.b.H., Staaken, Berlin
Engines:	Five 245 h.p. Maybach Mb.IVa engines
Dimensions:	Span, 42·2 m. (138 ft. 5½ in.)
	Length, 22·5 m. (73 ft. 10 in.)
	Height, 6·3 m. (20 ft. 8 in.)

Areas:	Wings, 334 sq. m. (3594 sq. ft.)
	Tailplanes, 32·4 sq. m. (349 sq. ft.)
	Elevators, 9 sq. m. (97 sq. ft.)
	Fins, 9·2 sq. m. (99 sq. ft.)
	Rudders, 3·6 sq. m. (39 sq. ft.)
	Ailerons, 7·15 sq. m. (77 sq. ft.)
Weights:	Empty, 10,000 kg. (22,050 lb.)
	Loaded, 14,250 kg. (31,421 lb.)
	Maximum useful load, 5000 kg. (11,025 lb.)
Performance:	Maximum speed, 135 km.h. (83·9 m.p.h.)
	Climbing speed, 95 km.h. (59 m.p.h.)
	Climb, 1000 m. (3281 ft.) in 7 mins.
	3000 m. (9843 ft.) in 45 mins.
	Ceiling, 4500 m. (14,764 ft.)
	Range with 1000 kg. bombs, 1300 km. (808 miles)
Armament:	Provision for dorsal and ventral machine-gun positions

Staaken R.XV

The Staaken R.XV series remain something of a mystery, for virtually no technical information exists to explain why these machines, though almost identical to the R.XIV type, received a different designation. The R.XV had the same engine configuration as the R.XIV and closely resembled the latter in outward appearance. It is probable that the R.XV was basically an R.XIV airframe modified to improve the performance by lightening the airframe. The airframe does show signs of greater attention to detail and streamlining; for instance, the nose cowling had more refined contours. If any other refinements were made they have not been recorded. There is no doubt, however, about the R.XV designation. The official German equipment tables for R-planes specified six machine-guns for this type.

Staaken R.XV 47/17.

The R.46/17, the first of three R.XV machines completed, was reported as being ready for its maiden flight on 25 July 1918 and was delivered in August. A contemporary status report stated that the R.47 and R.48 were expected to be completed on 3 August and 13 August respectively; they were both accepted on 1 September 1918. At least two of these aircraft saw service with R-plane squadrons on the Western Front.

As victor's spoils, the complete R.47 was shipped to Japan, and the Inter-Allied Control Commission team that inspected the Staaken factory found the R.48 there in 1919. It may have been parts of this aircraft that were sent to the Isle of Grain for study.

Staaken R.XV 48/17.

Colour Scheme and Markings

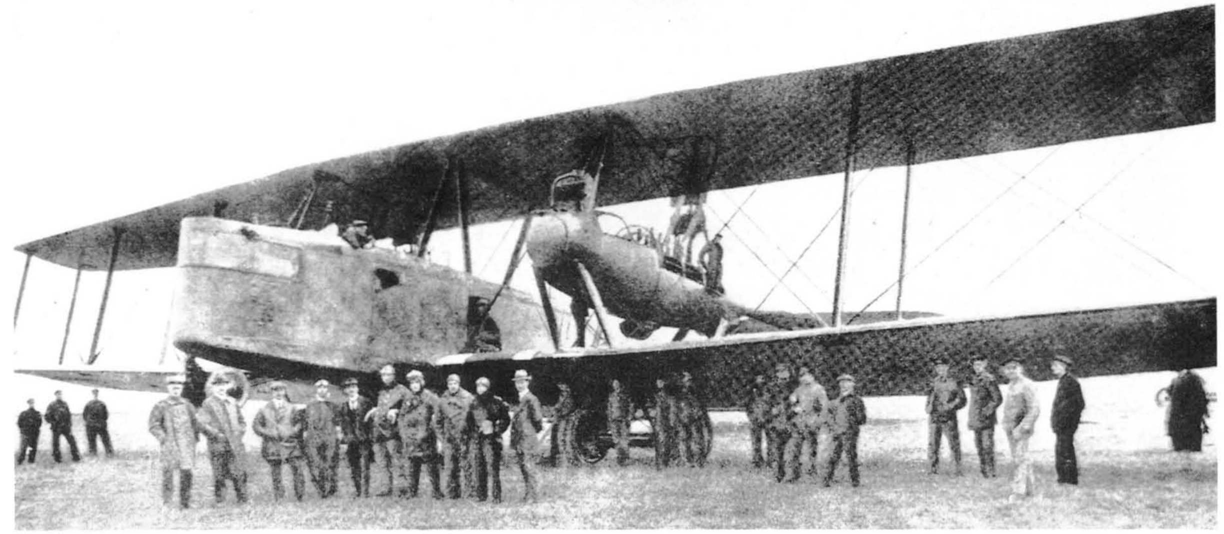
The R.XV machines were finished overall in printed camouflage fabric. The standard Latin cross was carried on wings, fuselage and tail. The serial numbers were painted in large white figures on the rear fuselage section.

SPECIFICATIONS

Type:	Staaken R.XV
Manufacturer:	Zeppelin-Werke G.m.b.H., Staaken, Berlin
Engines:	Five 245 h.p. Maybach Mb.IVa engines
Dimensions:	Similar to Staaken R.XIV
Areas:	Similar to Staaken R.XIV
Weights:	Unknown
Performance:	Unknown
Armament:	Similar to Staaken R.XIV

Staaken R.XVI

In its quest for ever greater R-plane performance and load-carrying ability, Idflieg placed an order for twenty 530 h.p. Benz Bz.VI twelve cylinder V-block engines in May 1917. Early in 1918 Benz & Co. A.G. in Mannheim had brought the development of their powerful engine to a point where limited quantities were available. The Aviatik concern was given the task of fitting these engines into the basic Staaken R.VI airframe. Aviatik, rather than Staaken, was selected because the Staaken firm was already fully committed to the development of all-metal aircraft. Aviatik possessed ample experience for the job, having already built the R.33 to R.35 and R.52 to R.54 under licence.



Staaken R.XVI (Av) 49/17.

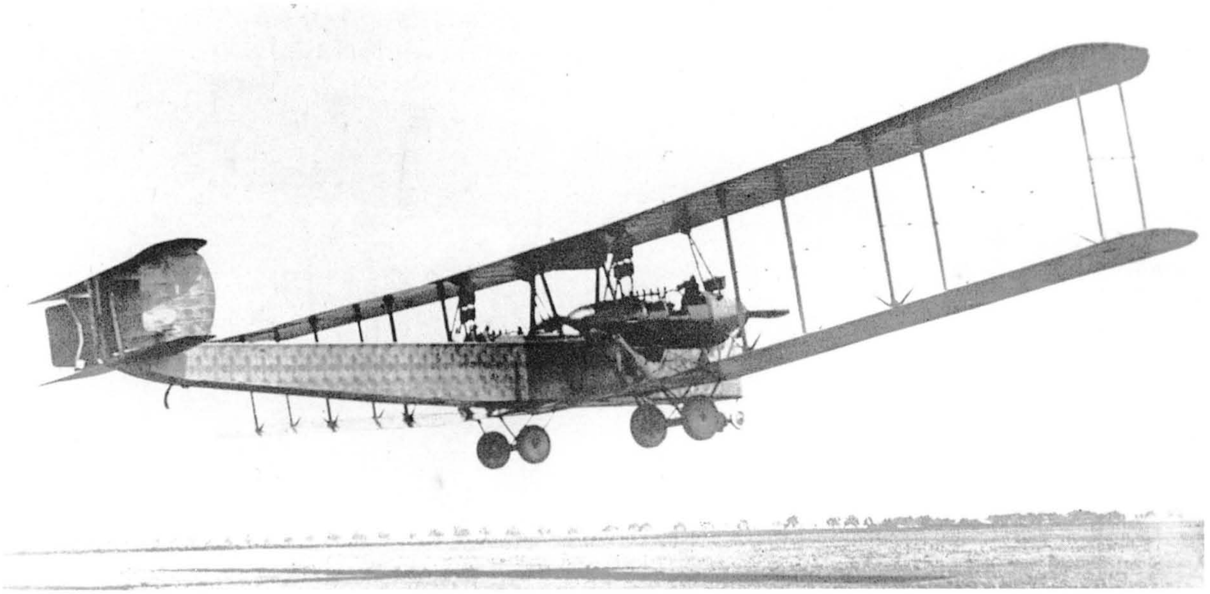
Three machines powered by the Bz.VI engine were ordered under the designation Staaken R.XVI (Av) R.49 to R.51. With the exception of the wings and nacelles, the airframe was outwardly identical to the R.52 series.

The chief characteristic of the R.XVI was the finely streamlined nacelle, the diameter of which was enlarged to accommodate the Bz.VI engine. The engine was mounted in the rear of the nacelle and drove a two-bladed pusher propeller through reduction gears. Initially the BuS.IVa engine was installed in the front of the nacelle behind a massive spinner. Recurrent problems made it necessary to replace it by a smaller 220 h.p. Benz Bz.IV engine. Judging from the size of the tractor propellers, it seems the Bz.IV engine was not equipped with reduction gears.

The nacelles were mounted in the wing gap by fore-and-aft splayed struts similar to those on the Staaken R.XIV. As usual, the radiators were mounted on struts above the engines. The Bz.VI engines each had two radiators, one for each bank of six cylinders. Large conspicuous oil coolers were located under the belly of each nacelle.

The wing area of the R.XVI was increased slightly, the trailing edge propeller clearance indentations were eliminated and the wing was strengthened, but in all other respects the wing structure remained similar to the R.XIV.

Staaken R.XVI (Av) 50/17.


The Staaken R.XVI (Av) 50/17 in flight.

By May 1918 the Bz.VI engine and reduction gear bench tests were well under way, and delivery of the R.49 was expected at the end of June. The military acceptance tests for the engine and gearing called for 10 hours running at an output of 500 h.p. at 1400 r.p.m. The status report for September 1918 states that the initial flights of the R.49 were most satisfactory. With a useful load of 4250 kg., an altitude of 4300 metres had been reached in 53 minutes, and no trouble was experienced with the engines. The following month the R.49 underwent its acceptance flights, during which one engine-out trials were conducted. During one of its flight tests it landed heavily, and the resultant shock collapsed the landing gear, which tore through the lower wing as the aircraft came to rest on its belly. The lower wings suffered severe damage, and it is doubtful if the R.49 was rebuilt.

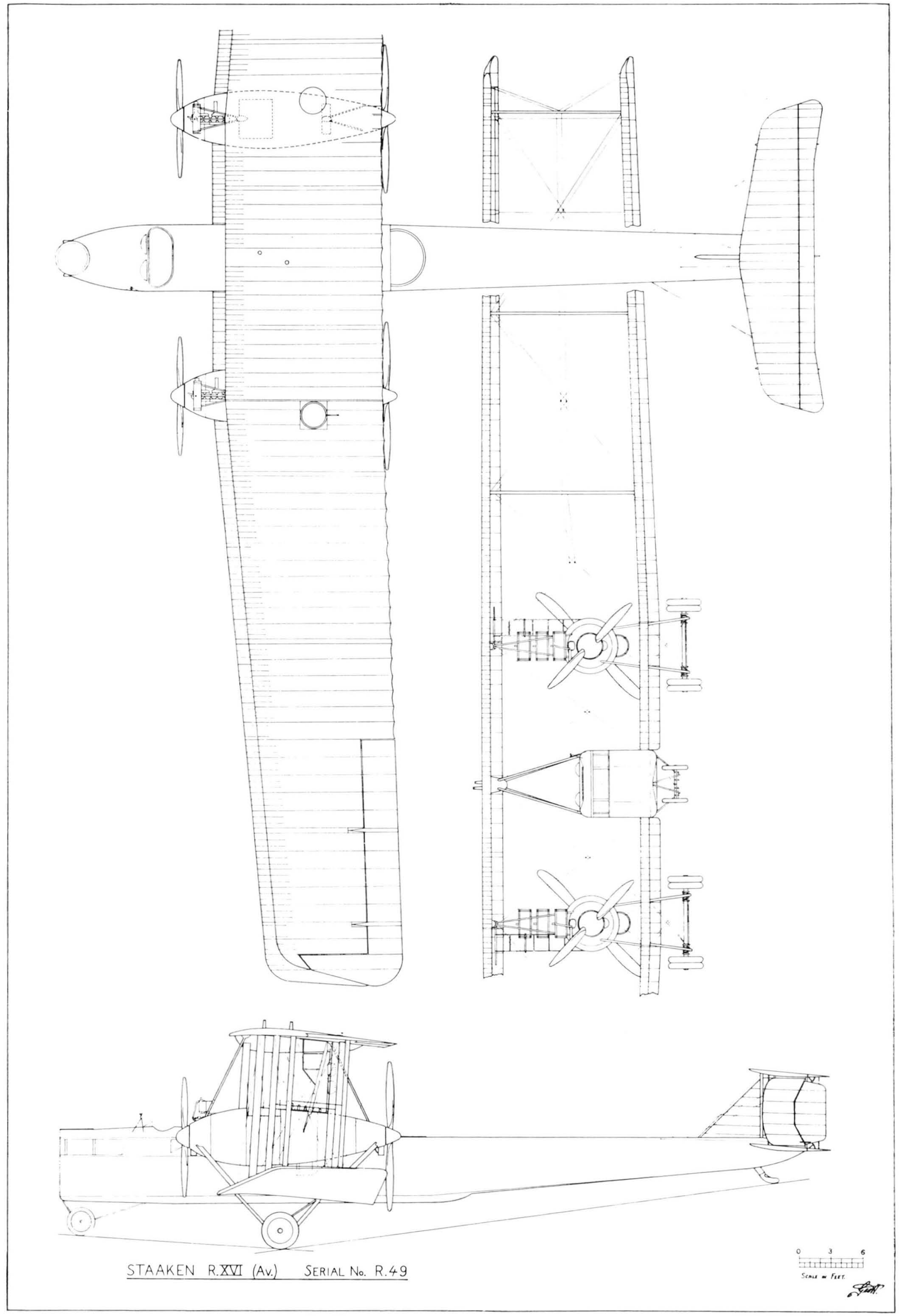
The R.50 was three-quarters complete on 12 January 1919, and was expected to be ready for flight on 15 February 1919. It was not completed as a bomber but modified into a civil machine and consequently differed in several respects from the R.49. The blades of the tractor propellers were increased in size, an indication that the engines were fitted with reduction gears. To save weight, the upper-wing gun mounts, ladders and bomb-bay fairing were removed.

The R.50 was proudly displayed by the Aviatik concern with the name "Aviatik" emblazoned in massive white letters across the underside of the lower wing and fuselage. Owing to conditions existing at the time, flight testing was inconclusive and the R.50 made its last flight in November 1919 when it was flown to Döberitz for storage. The third R.XVI, the R.51, also three-quarters completed in January 1919 was never finished, according to Aviatik chief engineer Ludwig Maurer, who wrote that only two R.XVI machines were constructed.

The R.XVI represented the ultimate development of the standard Staaken R-plane airframe. With its 1500 horse-power, the R.XVI was the most powerful aircraft built and flown by the Germans during the war. It is unfortunate that treaty limitations prevented a full investigation of the machine's potential civil capabilities.

Colour Scheme and Markings

The R.49 was finished overall in printed camouflage fabric; the polygons were rather small and the repeat pattern readily discernible. The standard Latin cross was carried on wings, fuselage and tail. The R.50 had chord-high letters "Aviatik" painted across the underside of the lower wing and fuselage. The aircraft carried no national markings.



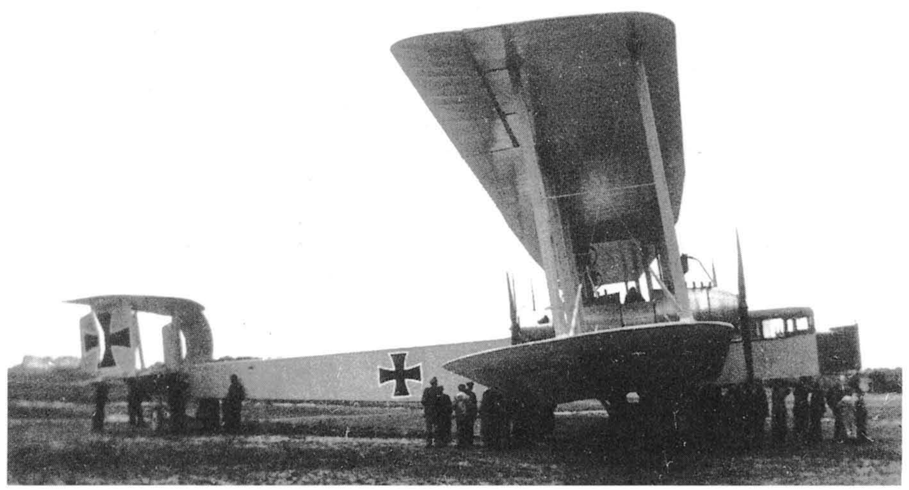
SPECIFICATIONS

Type:	Staaken R.XVI
Manufacturer:	Automobil & Aviatik A.G., Leipzig-Heiterblick
Engines:	Two 530 h.p. Benz Bz.VI pusher engines
	Two 220 h.p. Benz Bz.IV tractor engines
Dimensions:	Span, 42·2 m. (138 ft. $5\frac{1}{2}$ in.)
	Length, 22·5 m. (73 ft. 10 in.)
	Height, 6·5 m. (21 ft. 4 in.)
Areas:	Wing, 340 sq. m. (3658 sq. ft.)
Weights:	Empty, 10,400 kg. (22,932 lb.)
	Loaded, 14,650 kg. (32,303 lb.)
Performance:	Maximum speed, 130 km.h. (80·8 m.p.h.)
	Ceiling, 3710 m. (12,172 ft.) in 76·5 mins.
Armament:	Provision for nose, dorsal, ventral and two upper-wing machine-gun positions
Service Use:	None
Cost:	530,000 marks

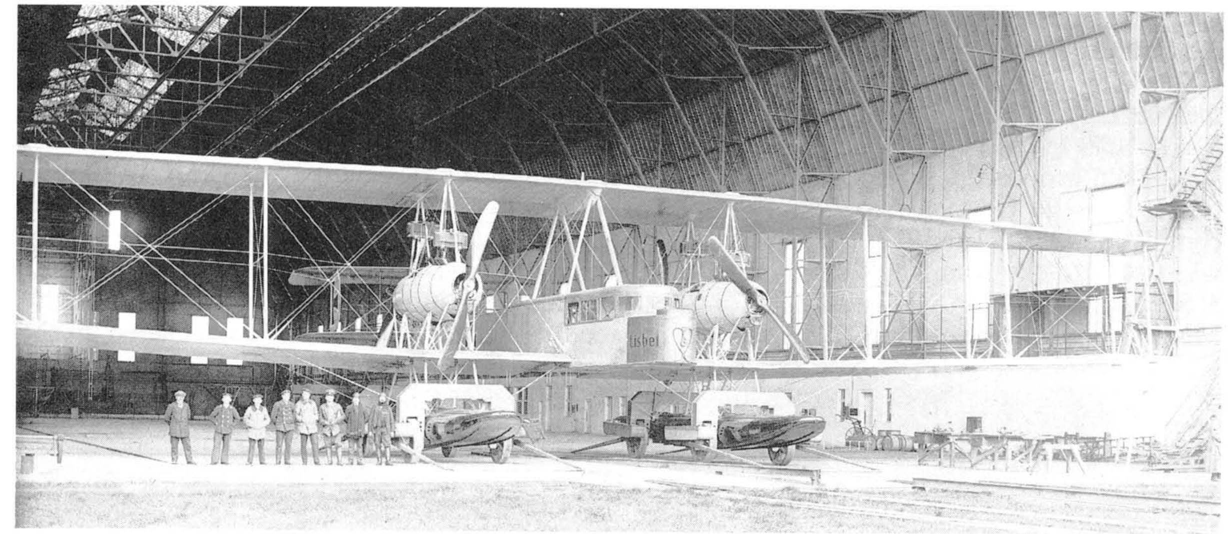
Staaken L

The German Navy's interest in R-planes did not wane with the destruction of its RML.1; on the contrary, Naval authorities actively continued to pursue the development of R-planes for use in naval warfare. As early as December 1916, Rear Admiral Philipp, Befehlshaber der Luftstreikräfte (Chief of Air Forces), had outlined future naval requirements and had established preliminary specifications as guidelines for aircraft manufacturers.

The reason for the increased emphasis on R-seaplanes was that English aircraft were very successful in attacking German airships. This resulted in a standing order that airships were to remain above 13,000 feet, which precluded their use as low-level submarine, shipping and mine spotters. Taking this into account, Admiral Philipp recommended the development and evaluation of less-vulnerable R-seaplanes of the flying-boat and floatplane category. Admiral Philipp listed the R-planes' advantages over the airship, as follows: they could fly faster, carry greater defensive armament, did not require huge hangars, could be readied for flight in a fraction of the time, used less personnel and were cheaper to build. The preliminary specifications for three classes of giant seaplanes were outlined in Admiral Philipp's memorandum of 26 December 1916:



Staaken L fitted with a wheeled undercarriage for delivery from Staaken to the company seaplane facility at Potsdam.



Staaken L on floats and carrying the nickname "Lisbet" in the Staaken hangar at Potsdam.

I. Reconnaissance Aircraft

(*a*) 1200 h.p. (four engines).
(*b*) Five crew, four machine-guns, wireless equipment, 100 kg. bombs, 10–12 hours duration.
(*c*) Rapid climb not required.
(*d*) Slow climb with one engine stopped, must maintain altitude on two engines.
(*e*) Take-off capability required in dead calm, wind and sea.
Take off in "*Seegang* 3" (wave height $\frac{3}{4}$–2 metres, wind force 4)
Landing in "*Seegang* 6" (wave height 5–7 metres, wind force 7–8)

II. Bomber Aircraft (four engines)

(*a*) Five crew, five machine-guns, wireless equipment, 1000–1800 kg. bombs, 5 hours duration.
(*b*) Minimum speed 130 km.h.
(*c*) Good climb.
(*d*) As in I(*d*).
(*e*) As in I(*e*).

III. Torpedo Aircraft (four engines)

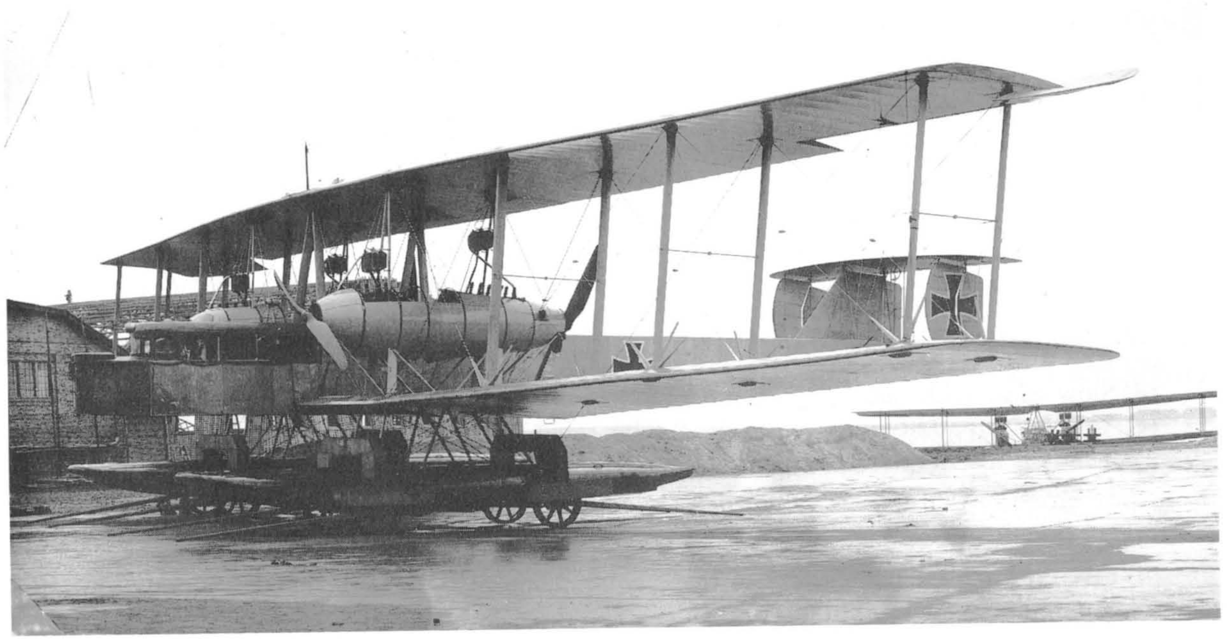
(*a*) Five crew, two machine-guns, wireless equipment, one G-Torpedo (1020 kg.), 8 hours duration.
(*b*) Maximum speed 130 km.h., minimum speed 80 km.h.
(*c*) Rapid climb not required.
(*d*) Slow climb with one engine cut. Must maintain altitude on two engines after torpedo has been dropped and with 2 hours fuel aboard.
(*e*) As in I(*e*)

Admiral Philipp went on to say; "Most urgent is the development of the reconnaissance R-plane." This statement was supported by a fair number of letters and notes in which high-ranking naval officers pressed for the immediate development of large reconnaissance aircraft for low-altitude spotting duties which the airship could no longer fulfil.

In a document dated 10 February 1917 Philipp defines more precisely the future role of the R-seaplane. Because the R-seaplane will be required to fly but 500 metres over the water, Philipp said, it must be endowed with greater reliability than any other type of aircraft, as a slight mechanical failure could force it down far out at sea. The projected task was low-level reconnaissance, primarily for mine-spotting, shipping control and anti-submarine duties.

On 26 December 1916 a report of Oberlt. z. S. Mans, who had just returned from an inspection of the Dornier R-flying-boat, ends with the comment that Luftschiffbau Zeppelin is to present a new proposal to meet the above-mentioned reconnaissance requirements. It should be noted that during the war only two companies, Staaken and Dornier, both part of the Zeppelin combine, delivered R-seaplanes to the Navy.

Staaken proposed a floatplane version of the Staaken R.VI, designated Staaken L, which was ordered by the German Navy on 15 February 1917 and assigned Navy number 1432. Upon completion in August 1917, the Staaken L, fitted with a standard R.VI wheeled undercarriage, was flown to the company's seaplane testing site at Potsdam where floats were mounted. On 5 September 1917 it was launched for the first time and promptly made two short flights. Modifications made during flight testing included replacing the narrow four-bladed pusher



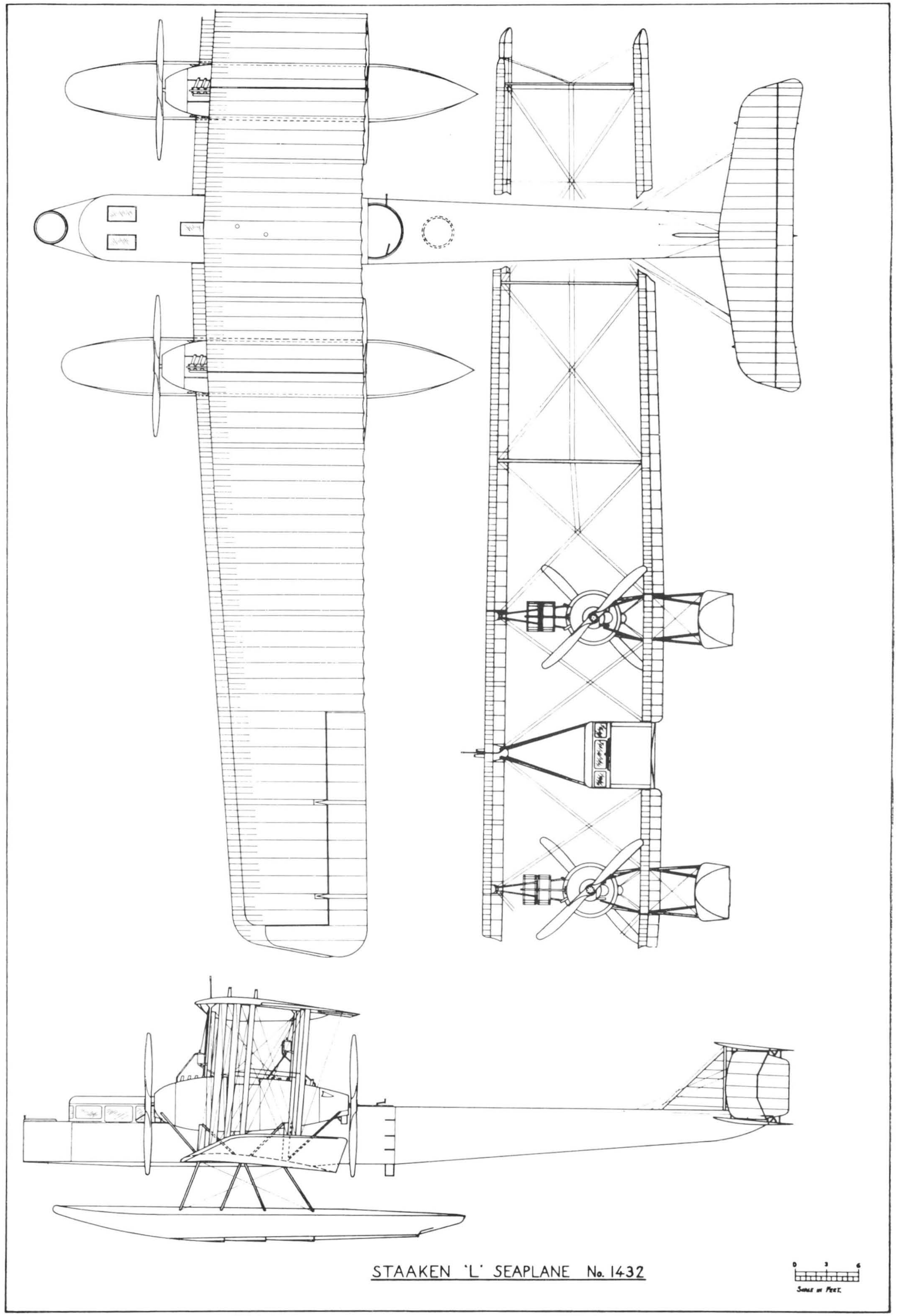
The Staaken L photographed at Warnemünde test centre on 13 February 1918.

propellers by standard two-bladed ones, adding a central fin to increase directional stability and reinforcing the float structure with extra struts. On 12 November 1917, the Staaken L left Potsdam on a cross-country delivery flight but owing to failure of one engine, was forced to land at Saaler Bodden, some 40 km east of Warnemünde. After repairs were made, the Staaken L was delivered to the Navy on 14 November 1917.

Apart from its floats, the Staaken L differed little from the standard Staaken R.VI. Minor changes included a 1½ degree sweepback starting at the centre line. The ailerons were aerodynamically balanced by large overhanging areas at the wingtips, and their chord was increased to counteract the lateral resistance of the floats. The total wing area, including ailerons, was increased to 360 square metres, and the fuselage bomb-bay fairing of the Staaken R.VI machines was eliminated.

The large all-duraluminium floats were extensively compartmented, so that in the event of springing a leak or receiving bullet holes, they would retain their buoyancy. The floats were attached by steel struts to the wing below the engine nacelles, and the absence of cross-bracing between the floats suggests the possibility that the area under the fuselage was left clear to provide means for evaluating the Staaken L as a bombing or torpedo plane at some later date. Indeed, the aircraft is classified as a bomber in official Navy documents.

Fourteen 245 litre fuel tanks in the fuselage, two 150 litre tanks in each engine nacelle and a 155 litre overhead gravity tank provided sufficient fuel for 10 hours cruising on all engines. During evalua-



tion tests a technique was developed to extend the range by cruising on only three engines, provided enough fuel had been consumed to reduce the machine's weight.

The Staaken L was equipped with Navy-developed transmitting and receiving gear, which was powered by a propeller-driven generator mounted above the wireless operator's compartment in contrast to the Army wireless equipment, which required a motor-driven generator. The aircraft was assigned to the Seeflugzeug-Versuchs-Kommando (Seaplane Testing Command) in Warnemünde for extensive tests and evaluation over a wide range of sea and weather conditions.

A special wooden hangar was designed and constructed by Firma Carl Tuchscherer in 1917 to house the Staaken L. Built on piles over the water, the hangar was unique in that the door was only 27·5 metres wide. A larger door capable of withstanding high seas and winds would have been difficult to install and maintain. Therefore, to keep the door small, it was decided to bring the aircraft into the hangar sideways, using a novel technique. Experiments had proved the impracticability of bringing an aircraft into a hangar sideways under even the slightest wind and wave conditions. Consequently, Tuchscherer proposed and built a pivoted, floating pier extending at right angles from one side of the hangar opening. The aircraft's left float was secured to the floating pier. Then the pier was swung around, its pivoted end turning the aircraft sideways through the opening into the hangar as it completed a 180 degree arc. The hangar trusses were capable of supporting a 12,000 kg. load, permitting the Staaken L to be lifted for repairs to the floats. A second, much larger hangar capable of housing four R-planes was under construction at the close of the war.

The Staaken L crashed over Warnemünde on 3 June 1918 killing the pilot, Lt. Haller and the crew.[1] Very little is known regarding the outcome of the Staaken L evaluation tests. It was not as stable on the water as the Dornier R-flying-boats. The wing tips would touch the water at a 7 degree heel, whereas the flying-boat required a 14 degree heel. Nevertheless, it was a proven design that Staaken had built in quantity, and it could be produced in less time than the all-metal Dornier flying-boats. Six further Staaken R-seaplanes based on the Staaken L were ordered by the Navy.

Colour Scheme and Markings

The Staaken L was finished overall in a light colour and carried the Patée cross insignia outlined in white on wings, fuselage and tail. Contrary to usual Naval practice, the serial number was not painted on the fuselage. At Potsdam the Staaken L was named "Lisbet" and this name was painted in black capitals on both sides of the fuselage.

SPECIFICATIONS

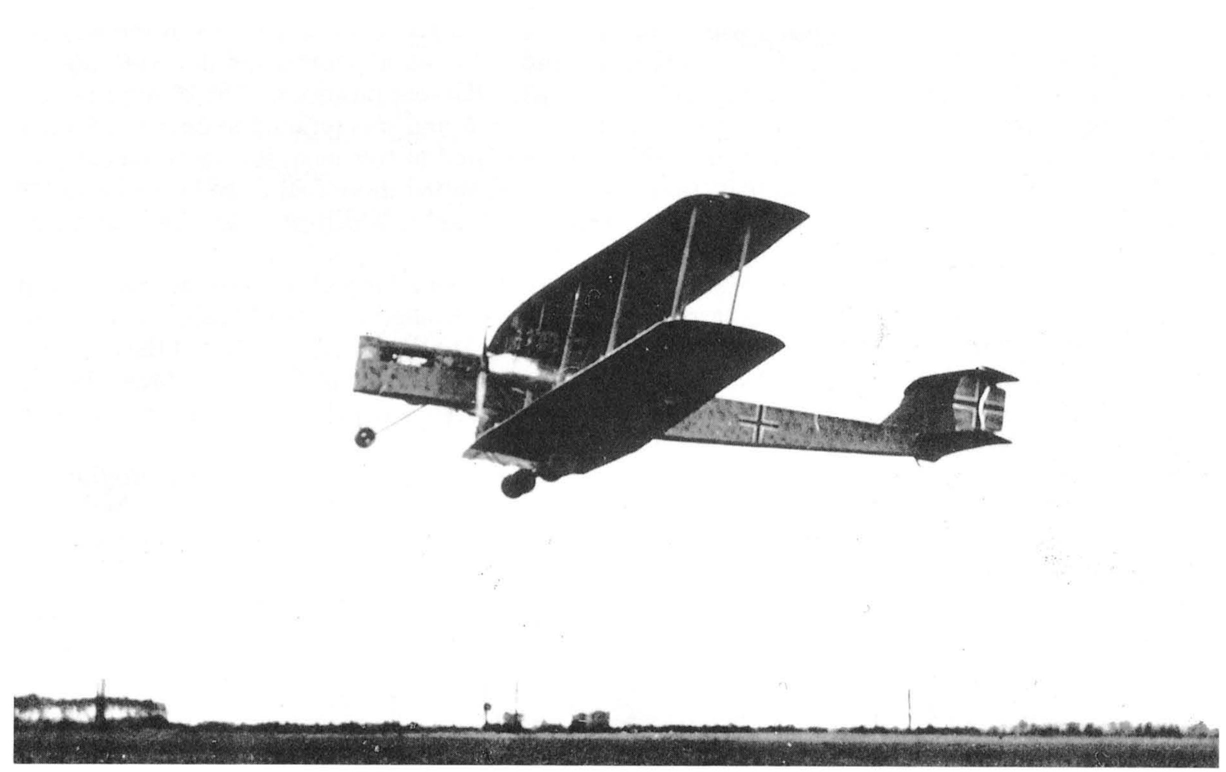
Type:	Staaken L
Manufacturer:	Flugzeugwerft G.m.b.H., Staaken, Berlin
Engines:	Four 260 h.p. Mercedes D.IVa engines
Dimensions:	Span, 42·2 m. (138 ft. 5½ in.)
	Maximum Chord, 4·53 m. (14 ft. 10 in.)
	Maximum Gap, 4·55 m. (14 ft. 11 in.)
	Length, 22·2 m. (72 ft. 10 in.)
	Height, 7·38 m. (24 ft. 2½ in.)
	Propeller diameter, 4·4 m. (14 ft. 5 in.)
	Propeller centres, 8 m. (26 ft. 3 in.)
	Float length, 12 m. (39 ft. 4½ in.)
Areas:	Wings, 360 sq. m. (3874 sq. ft.)
Weights:	Empty, 8400 kg. (18,522 lb.)
	Loaded, 11,800 kg. (26,019 lb.)
	Floats, 600 kg. (1323 lb.)
	Fuel, 2445 kg. (5391 lb.)
Wing Loading:	32.77 kg./sq. m. (6·7 lb./sq. ft.)
Performance:	Maximum speed, 125 km.h. (77·7 m.p.h.)
	Landing speed, 85 km.h. (52·8 m.p.h.)

[1] The Report of the Aircraft Section of the Allied Naval Armistice Commission states: "The 1432 crashed on its trials at Warnemünde owing to the engines failing whilst over the land, and the crew including Kapt. Lt. Kirsch, who was in charge of wireless experimental work, were killed."

	Climb with full load, 1000 m. (3281 ft.) in 23·7 mins.
	1780 m. (5840 ft.) in 60 mins.
	Ceiling, 2500 m. (8202 ft.)
	Duration, 10 hrs.
Fuel:	3395 litres (747 Imp. Gals.)
	Oil, 320 litres (70·4 Imp. Gals.)
Armament:	Provisions for nose, dorsal and ventral machine-gun positions
Service Use:	None

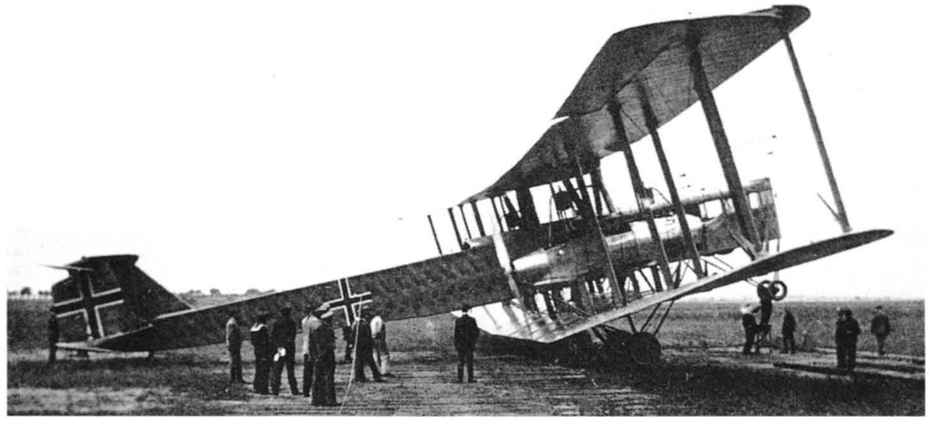
Staaken 8301 and 8303 Types

In December 1917 the German Navy placed an order for two Staaken seaplanes, numbered 8301–8302, followed in January 1918 by an additional order for four slightly-improved seaplanes numbered 8303–8306. The design of these machines incorporated the lessons learned from the extensive Staaken L test programme. Although the general layout remained unchanged, a major modification consisted of raising the fuselage several feet above the lower wing as in the Bristol Fighter. By



Initial flight form of the Staaken 8301 Seaplane.

raising both fuselage and tail farther above the water, they were better protected from the spray and buffeting of rough seas. The forepart of the fuselage was modified to bring the nose gun ring level with the upper longerons to provide more space in the nose compartment. Cellon windows ran around the entire nose, providing an unobstructed view in all directions. The nose compartment just forward of the two pilots' seats contained the bomb-release mechanism for the ten 10 kg. bombs which were stored in two containers along each side of the nose. Also located in the nose was an anchor winch and sufficient line for hoisting a small anchor which was hung externally in front. A collapsible mast antenna made it possible to transmit signals while the machine was afloat.

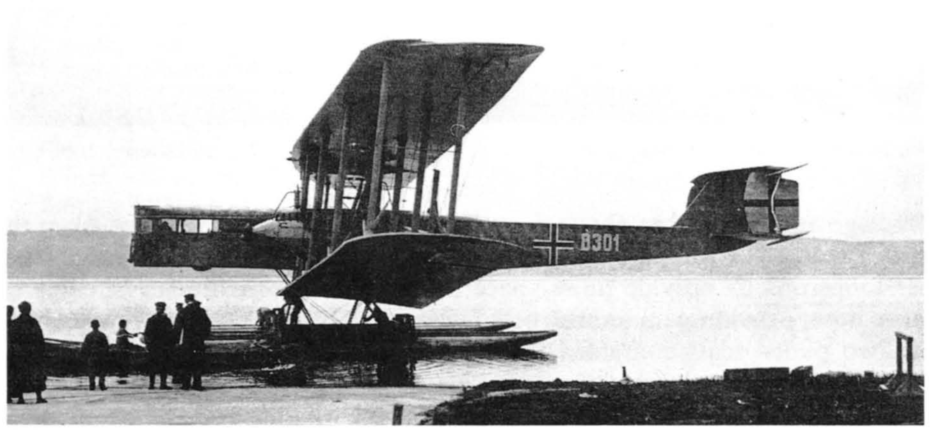


Staaken 8301 Seaplane fitted with wheels for the delivery flight to Potsdam.

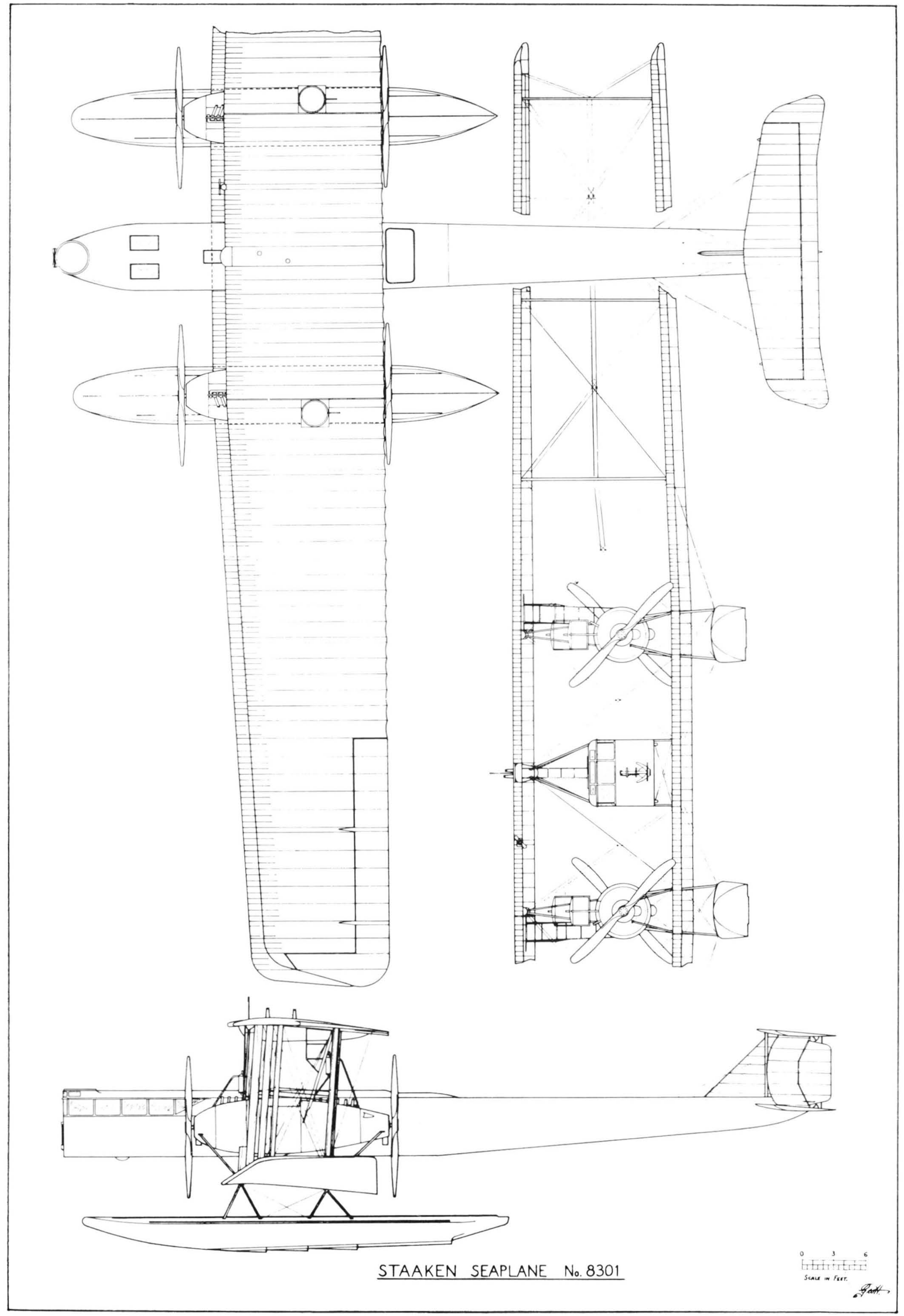
In all other respects the Staaken 8301 and 8303 machines made use of the refinements found on the latest Staaken land R-planes. The wings and their control surfaces resembled the wings of the Staaken R.XIV, and the tail was fitted with aerodynamically-balanced elevators. As in the R.XIV, machine-gun positions were placed in the upper wings and in the usual ventral and dorsal locations. Provision was made to mount two 20 mm. Becker cannons in the rear positions. The 20 mm. Becker had been experimentally fitted to smaller German naval aircraft and was reputed to be very effective against small ships, submarines and aircraft. The crew consisted of five men, less than the complement of the Staaken landplanes. The reduction in weight permitted more fuel to be carried and the 8301 and 8303 types were equipped with twelve 300 litre fuel tanks, which provided for a duration of 9–10 hours cruising on all four engines.

The Staaken 8301 made its first flight in the summer of 1918 as a landplane. For this purpose, it was fitted with a standard-wheeled undercarriage, such as was installed on other Staaken landplanes. However, the auxiliary nose gear had to be lengthened to allow for the higher location of the fuselage. After completion of initial trials, the 8301 was mounted on duraluminium floats that were slightly longer and differently suspended than on the Staaken L. The floats were divided into twelve air-tight compartments to localize flooding in case of damage.

The 8301 and later the 8302 were based at Warnemünde for naval tests. This testing programme was halted at the end of the war, and it is believed the machines were not accepted by the Navy. After the war an Allied naval commission, inspecting German bases, was impressed by the over-

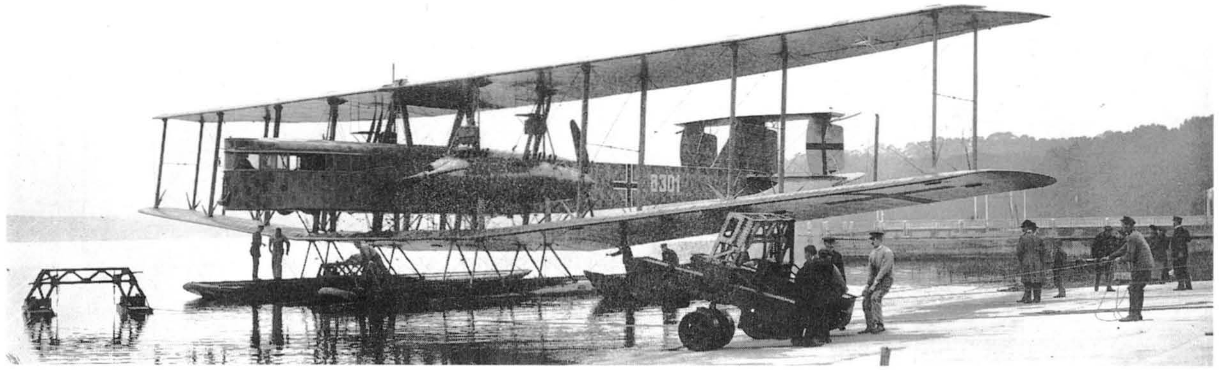


Staaken 8301 Seaplane during flight testing on the Havel at Potsdam.



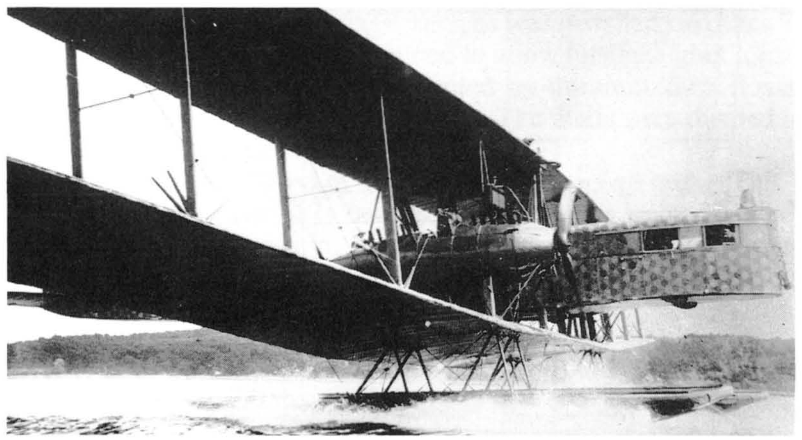
whelming size of the 8301 and 8302, and described them as dwarfing the 200-odd aircraft stationed at Warnemünde.

The slightly improved 8303 series, ordered shortly after the 8301, was never delivered, but two completed machines, the 8303 and 8304, were found in the Staaken seaplane hangar at Wildpark



Staaken 8301 Seaplane.

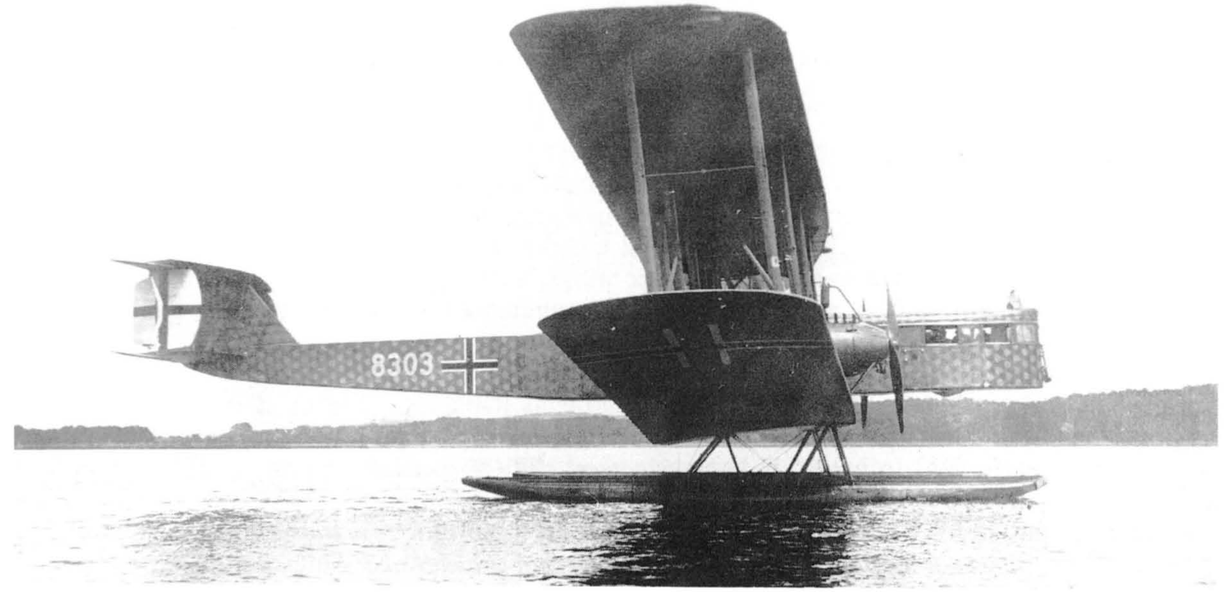
near Potsdam by the Inter-Allied Control Commission. It should be noted that the not always reliable I.A.C.C. report claimed that three Staaken R-seaplanes were destroyed in tests. The most notable modification possessed by the 8303 types was the return to swept-back wings similar to the Staaken R.XIV.



The Staaken 8303 Seaplane taking off.

In the early post-war period 8301 and possibly 8303 and 8304 were used on regular weekend passenger excursions between Berlin and Swinemünde, a popular German coastal resort.

The Staaken R-seaplanes were by far the largest floatplanes ever constructed. Sikorsky had mounted his "Ilia Mourumetz" on floats for the Imperial Russian Navy in 1914–15, and Caproni produced a floatplane version of his famous triplane, but neither aircraft approached the Staaken machines in size. Since 1917 there may have been floatplanes which exceeded the Staaken machines in weight, but no record has been found of a floatplane with greater wingspan than the Staaken seaplanes.



Staaken 8303 Seaplane.

Colour Scheme and Markings

All machines were finished overall with printed camouflage fabric using rather small polygons. Narrow Latin crosses edged in white and spanning the full wingtip chord and depth of fuselage were carried. On the rear fuselage the naval number was painted in large white figures.

SPECIFICATIONS

Type:	Staaken 8301 and 8303
Manufacturer:	Zeppelin-Werke G.m.b.H., Staaken, Berlin
Engines:	Four 260 h.p. Mercedes D.IVa engines
Dimensions:	Span, 42·2 m. (138 ft. 5½ in.)
	Length, 21 m. (68 ft. 10½ in.)
	Height, 6·8 m. (22 ft. 3½ in.)
Areas:	Wings, 340·5 sq. m. (3663 sq. ft.)
Weights:	Empty, 9000 kg. (19,845 lb.)
	Loaded, 12,500 kg. (27,563 lb.)
Performance:	Maximum speed, 130 km.h. (80·8 m.p.h.)
	Climb, 3000 m. (9843 ft.) in 54 mins.
Service Use:	None

Staaken R-plane Projects

Staaken engineers were active in investigating new rib sections, undercarriage assemblies, geodetic structures and the hundreds of constructive details that comprise an R-plane. During their stay at Gotha, VGO engineers had already begun work on an enlarged R-plane design. Philipp Simon, head of the materials testing laboratory, recalls that it was a biplane with wings of 50 metre span and 6 metre chord. He continues:

> The power plants were not known to me, but we built a substantial wing section for experimental load testing. It was a rather big undertaking, as we had to simulate flight

loads by sand loading to a carefully prepared profile until the final collapse. But the project, which had cost the firm a considerable sum, was never continued.

Information regarding the Staaken projects under design or construction in 1917 and 1918 is sparse, and what has come to light is the subject of much intriguing speculation.

In 1917 the military authorities began to support the development of high-performance R-planes capable of executing daylight attacks. In order to achieve this goal an increase in overall performance was mandatory. Engineers had to resort to the latest materials and construction techniques and utilize the newest aerodynamic concepts if an R-plane capable of meeting enemy fighters on equal terms was to become a reality. It was logical that the choice would fall on all-metal R-monoplanes with accessible engines buried in thick, cantilever wings, a configuration developed by Junkers and adopted by AEG and Staaken, all of whom had R-monoplanes in various stages of completion at the end of the war.

In the case of Staaken, transfer of engineers fully versed in Dornier's revolutionary metal fabrication process enabled Staaken to begin building all-metal R-planes. The most important of these engineers was Dr. Adolf Rohrbach, an associate of Dornier since 1914, who moved to Staaken in late 1916 or early 1917 to bring his knowledge and skills to bear on the all metal R-monoplane problem.

Von Bentivegni, in his writings, has fortunately left an important clue to the configuration of one of the Staaken R-monoplane projects. It had thick semi-cantilevered wings and was powered by five tractor engines, easily accessible in the wings and nose. A machine-gun position was located behind each engine, and armour plate protected the few but large fuel tanks in the fuselage behind the pilots' seats. The speed of the projected machine was considerably greater than that of existing R-planes. While the designation of this project is unknown, it is entirely possible that this project resembled the post-war all-metal monoplane, the Staaken E.4/20, designed by Dr. Adolf Rohrbach.

Two other Staaken Army R-plane projects have been identified. The first was known as the Staaken R.VIII, of which three examples numbered R.201/16 to R.203/16 were ordered by Idflieg. The Staaken R.VIII was to have been an all-duraluminium bomber powered either by eight 260 h.p. Mercedes D.IVa or 245 h.p. Maybach Mb.IVa engines. The second project was the Staaken R.IX 206/16, which, as far as is known, was similar in all respects to the Staaken R.VIII.

In a March 1918 status report it states:

> Staaken R.VIII 201/16 and 206/16 (2000 h.p.). Because of the final decision to construct the wings completely from metal rather than wood, the design has to be reworked and work must proceed at top speed. The Zeppelin-Werke hope, still within this month, to order the duraluminium parts for the wings in order to start assembly beginning May.

The drawings for both the R.VIII and R.IX were reputed to have been completed by April 1918. In the same report we learn that various armour-plated fuel tanks, both elliptical and diamond shaped, were under construction by Staaken.

The next month we read:

> For R-planes, the first cone-shaped armoured fuel tanks are completed and will be installed in a Staaken R-plane for tests. Although a final decision has not yet been made it is planned to construct the middle section of the 2000 h.p. Staaken R-plane as a fixed armoured structure.

An Idflieg document, dated 15 March 1918, rather optimistically listed the intended delivery date for the R.201 as October 1918. It has not been determined when the construction of the R.201 was begun (if at all), how far it progressed and what its design looked like, other than that it was to be an all-metal monoplane.

It is difficult to determine why such high serial numbers were assigned out of sequence, unless the reason was that the Government purposely set these numbers aside for long-range development programmes.

No information exists regarding the Staaken R.X to R.XIII. If these numbers existed at all it is believed that they were set aside for project bureau studies.

The final Staaken project was a seaplane powered by four 530 h.p. Benz Bz.VI engines and assigned Navy Number 8307. It was ordered by the Navy in February 1918. Although further details are missing, it might be speculated that this machine resembled the Staaken R.XVI (powered by Benz Bz.VI engines) on floats.

Much technical material was deliberately destroyed or hidden by the Germans in 1919 to avoid its falling into the hands of the Inter-Allied Control Commission. The secrecy which surrounded these projects and the early post-war failure of the Staaken concern, in addition to the destruction of records in World War II makes it doubtful if the full story of the Staaken projects will ever be known.

SPECIFICATIONS

Type:	Staaken R.VIII and R.IX
Manufacturer:	Zeppelin-Werke G.m.b.H., Staaken, Berlin
Engines:	Eight 260 h.p. Mercedes D.IVa engines or Eight 245 h.p. Maybach Mb.IVa engines
Dimensions:	Span, 55 m. (180 ft. 5 in.) Length, 30 m. (98 ft. 5 in.) Height, 8·8 m. (28 ft. 10 in.)

SPECIFICATIONS

Type:	Staaken 8307
Manufacturer:	Zeppelin-Werke G.m.b.H., Staaken, Berlin
Engines:	Four 530 h.p. Benz Bz.VI engines

Staaken E.4/20

The all-metal Staaken E.4/20 four-engined monoplane, the last creation of the dying R-plane industry, was visible proof of the progress which the Germans had made in the design and construction of large all-metal aircraft during the war years. Standing on its own merit, the Staaken E.4/20 was truly the world's first modern transport aircraft, and its functional lines belie the fact that it was built as early as 1919–20.

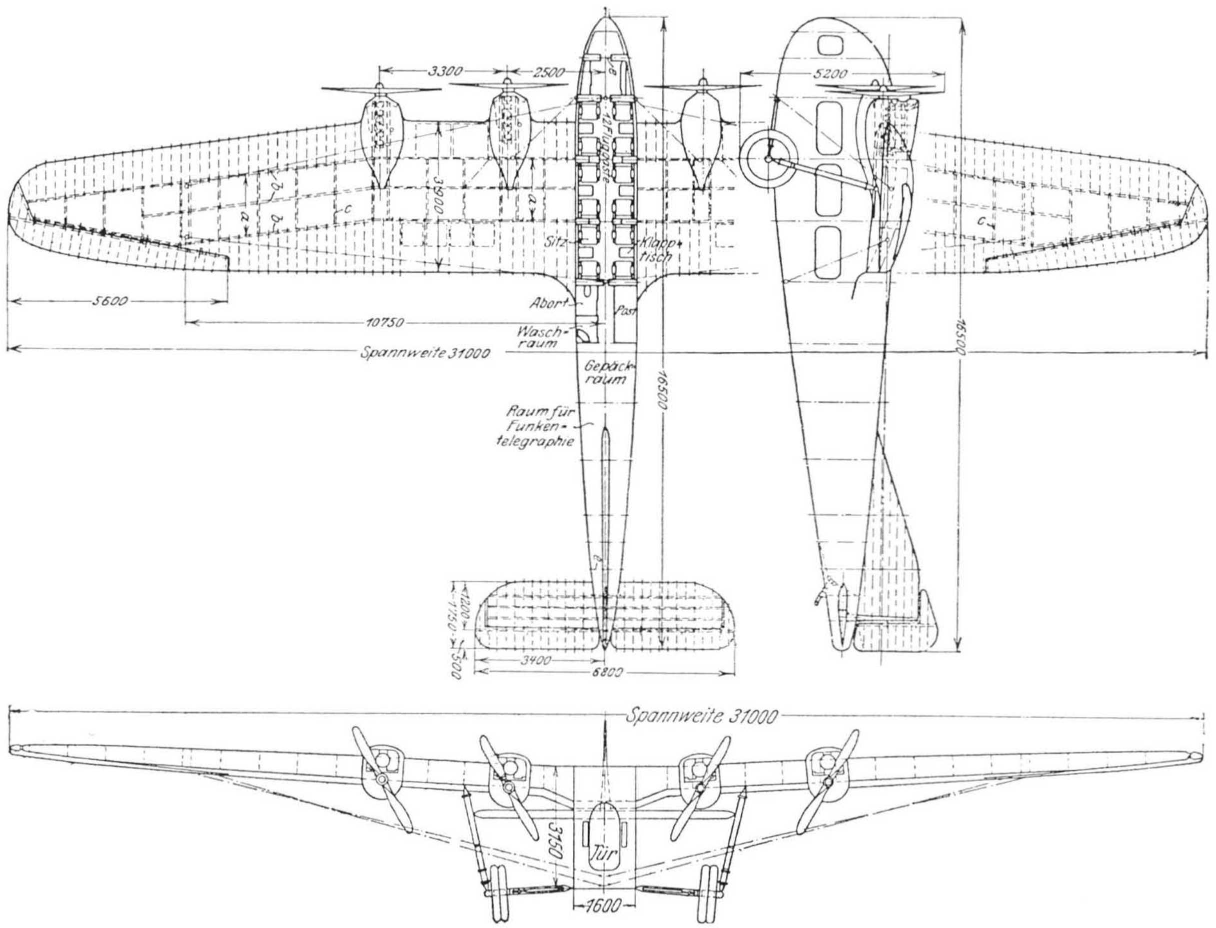
The construction of the E.4/20 was begun in May 1919 at the direction of Alfred Colsman, general manager of the Zeppelin combine; one of the stipulations was that the fully-loaded aircraft should be able to remain airborne on the two engines. It was planned to place the E.4/20 in service as a commercial passenger transport between Friedrichshafen and Berlin. There can be no question that the design of the E.4/20 owed much to the all-metal monoplane bombers which Staaken was developing under Idflieg contract in 1918. Although strictly a transport aircraft, the E.4/20 could not have differed appreciably in layout from these projects. With an additional engine mounted in the nose, the E.4/20 could well have been the Staaken five-engined bomber design described by von Bentivegni in 1919 (see Staaken Project chapter).

As related previously, Dr. Adolf Rohrbach, an engineer who had been very active in the development of metal construction techniques at Dornier, was transferred to Staaken in 1916–1917 to apply his talents to all-metal R-landplane design. Dr. Rohrbach had been hand-picked by the head of the Staaken R-plane Construction Department, Prof. Baumann, to be his successor, and this he became in 1919, when he assumed technical leadership of the Staaken organization.

Viewed in relationship to the wood and fabric civil aircraft of the immediate post-war era, the E.4/20 was indeed a pioneering achievement of the first magnitude. With the exception of refinements in detail, the construction techniques were very similar to those common today. The airframe

was built wholly from specially formed duraluminium profiles riveted together and covered with a thin-riveted duraluminium skin. This construction method was simply an extension of the process devised by Dornier which found expression in a very modern airframe.

The most striking feature was the large cantilever wing, which had a wingspan of 31·0 metres (101·7 feet) and featured a thick wing section based on the aerodynamic investigations of Professor Junkers. The wing was built around a single riveted box-spar of very large dimensions; its width constituted one-third of the wing chord, and at the wing roots its depth was 1·5 metres (4·9 feet). The leading and trailing edge wing sections and engine bearers were attached to this massive central spar. The leading-edge skin was formed of 4 mm. thick duraluminium sheet, the box-spar covering 3 mm. thick and the trailing edge 2 mm. thick, while the remainder of the wing was covered with fabric.



Staaken E.4/20 Civil airliner

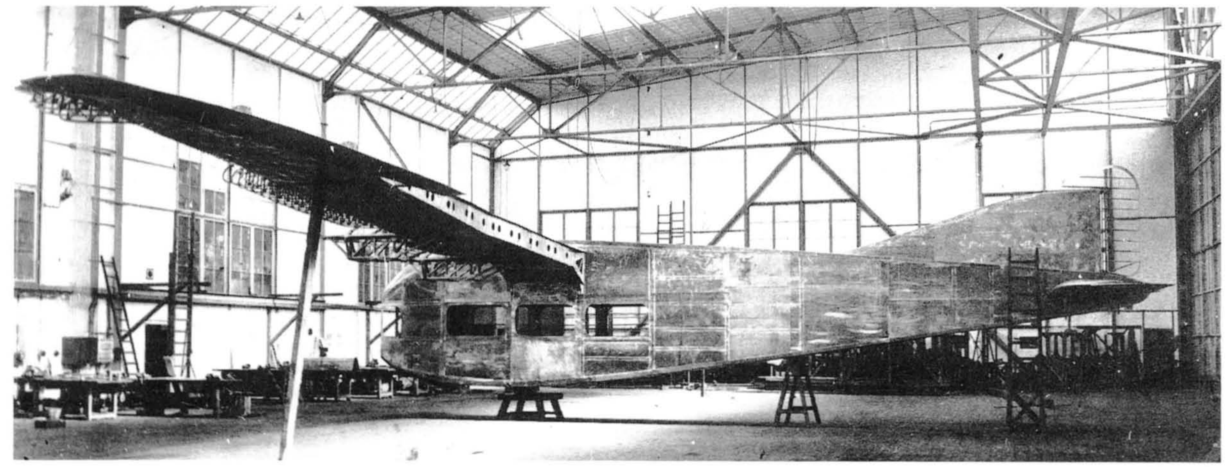
The box-spar was pierced by an oval opening which permitted a mechanic to crawl behind the engines, although it would seem difficult to perform extensive in-flights repairs in the small space provided.

The wing loading—extremely high for its day—was 80 kg./sq.m., a value almost double that of a comparable monoplane, the Dornier Rs.IV (46·5 kg./sq.m.). Because practical experience with such high wing loads was not available, it was deemed prudent to provide supplementary wing-bracing cables primarily as a safety feature. However, the wing structure had been calculated to withstand the dynamic flight loads without any additional supporting cables or struts.

The four 245 h.p. Maybach Mb.IVa engines were mounted on a robust framework extending from the central box-spar, and their outline was neatly cowled into the wing. The engines were placed

ahead of the leading edge in a manner shown feasible by tests conducted at the Dornier works in 1917 (see Dornier Projects chapter). Fuel was contained in two large tanks placed in the leading edge between the engines and four smaller tanks situated in the trailing-edge wing section.

The fuselage consisted of fourteen rectangular frames attached at each corner to four angle-shaped longerons running the whole length of the fuselage. The duraluminium skin riveted to the fuselage framework provided the required stiffness in the absence of diagonal bracing between adjacent frames. In the rear of the fuselage light metal straps riveted across the corners of each frame gave torsional stiffness. The two frames which supported the wing were solidly constructed of riveted box-sections. To prevent buckling and resonance vibrations of the skin, light reinforcing stringers were riveted to the inside of the skin, giving an appearance of extra longerons.


The Staaken E.4/20 under construction.

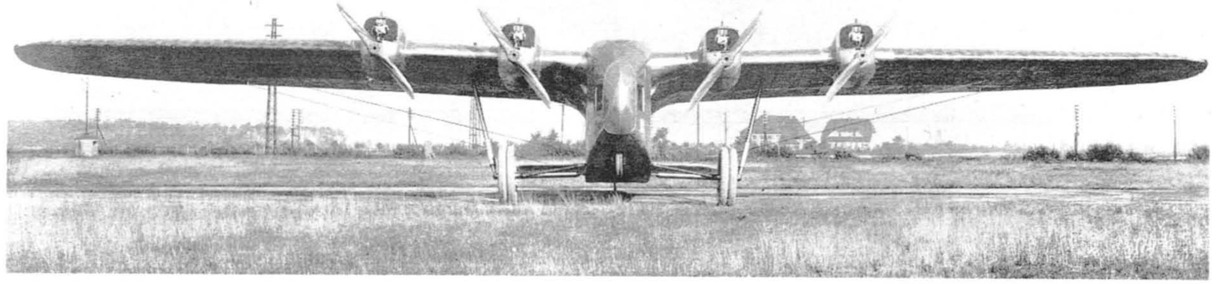
The open pilots' cockpit was located atop the fuselage slightly forward of the wing leading edge and commanded an excellent view. At a later date the nose decking was lowered and a fully-enclosed pilots' cabin with Cellon windows was installed. A door in the nose allowed passengers to enter the fuselage, which could accommodate twelve to eighteen persons seated two abreast. A large mail compartment, toilet, separate wash-room and luggage space were located in the rear of the fuselage.

The tail assembly consisted of a fixed tailplane and fin of cantilever construction covered with duraluminium sheet. The elevator and rudder were aerodynamically-balanced and covered with fabric. The ailerons, of very small chord, were fully balanced and hinged to the ends of the wing spar.

The twin wheels were supported by a very simple undercarriage made up of one heavy strut, which contained the shock absorber and was attached to the wing spar between the engines. Two horizontal struts were affixed to the lower corner of the fuselage and converged at the axle.

While the aircraft was under construction the Inter-Allied Control Commission inspected the framework and permitted Staaken to complete the E.4/20 in spite of the prohibition clauses in the peace treaty. The Commission felt that they could not pass judgement on the aircraft's military potential until it was completed and had performed flight tests. Naturally, Allied engineers attached to the Commission followed the assembly progress with a high degree of interest.

The E.4/20, completed 30 September 1920, performed a number of exceedingly promising flights with test pilot Carl Kuring at the controls. During one flight made under optimum conditions the aircraft was clocked at 225 km.h., an unheard-of speed for an aircraft of that size. It was found, however, that it was not possible to maintain flight on two engines as had been hoped. Further test flights were prohibited by the Inter-Allied Control Commission, which was now convinced that the E.4/20 did indeed have military potential and as such violated the treaty stipulations. Director Colsman wrote that the Commission also refused the E.4/20 to be sold or given away, leaving



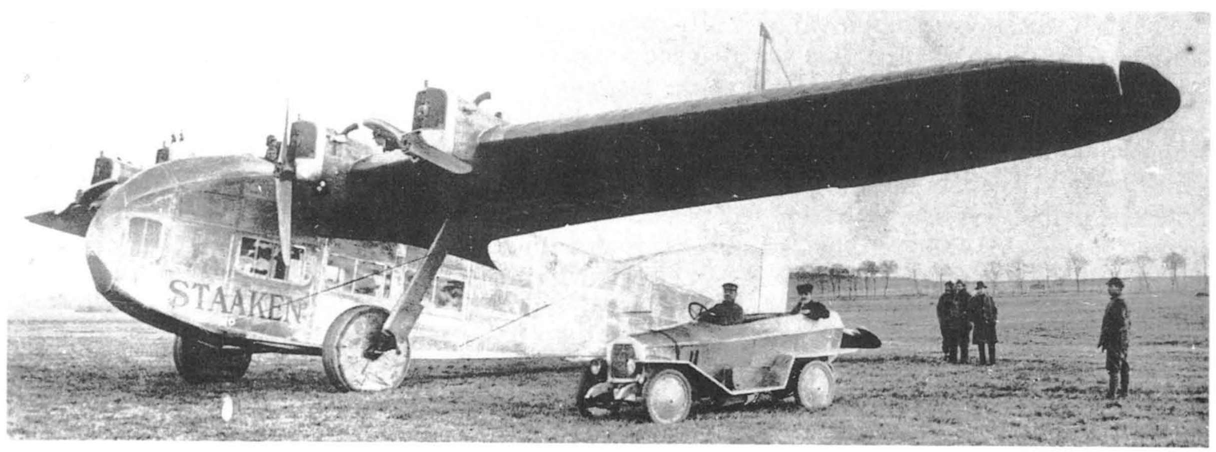
Staaken E.4/20.

Staaken no recourse but to scrap the machine. It was Colsman's opinion that the Commission acted as it did in order to financially cripple the Zeppelin concern and destroy its ability to perform further work in this field. This action can be understood in the light of the Commission's charter to prevent the resurgence of a military aircraft industry in Germany. With its superb performance, the E.4/20 could have been a bombing weapon to fear.

The aircraft was scrapped on 21 November 1922, destroying in the process the forerunner of the modern transport aircraft. The significance of the E.4/20 in future aircraft development has been largely forgotten, and it is a pity that Rohrbach and Staaken never had a chance to develop its full peacetime potential. To Dr.-Ing. Adolf Rohrbach must go the credit for having conceived an aircraft formula which virtually all large transport and militray aircraft were to follow for a great many years.

SPECIFICATIONS

Type:	Staaken E.4/20
Manufacturer:	Zeppelin-Werke G.m.b.H., Staaken, Berlin
Engines:	Four 245 h.p. Maybach Mb.IVa engines
Dimensions:	Span, 31·0 m. (101 ft. 8 in.)
	Length, 16·5 m. (54 ft. 1 in.)
	Height, approx. 4·5 m. (14 ft. 9 in.)
Areas:	Wings, 106 sq. m. (1141 sq. ft.)
Weights:	Empty, 6072 kg. (13,389 lb.)
	Loaded, 8500 kg. (18,743 lb.)



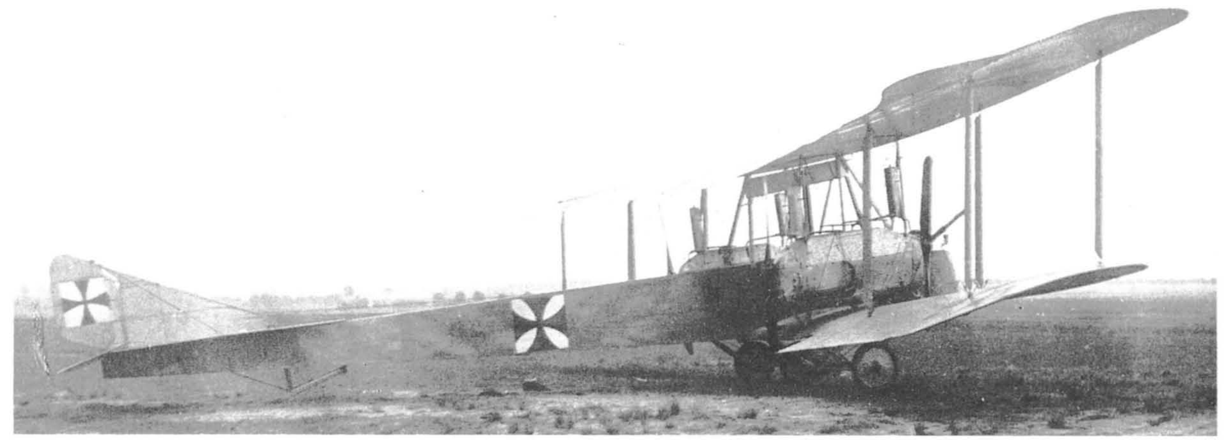
The Staaken E.4/20 all-metal airliner of 1920.

Wing Loading:	80 kg. sq. m. (16·4 lb./sq. ft.)
Performance:	Maximum speed, 225 km.h. (140 m.p.h.)
	Cruising speed, 200 km.h. (124 m.p.h.)
	Duration, 5–6 hrs.

Union G.I

In 1912 the Union-Flugzeugwerke G.m.b.H. was founded at Teltow near Berlin by an aircraft designer named Karl Bomhard, who had previously participated in the design of the Lohner arrow-biplanes (Pfeilflieger) in Austria. He was joined by Dr. Josef Sablatnig (in 1913) and Georg König. These two engineers constructed the Union arrow-biplanes based on Bomhard's designs, which were then quite the vogue. One of these aircraft won three world-altitude records with passengers for Germany in 1913.

At the end of the year 1914 Union began construction of a large four-engined bomber which fell



The Union G.I experimental bomber.

into the same category as the SSW-Forssman R-plane and, like this machine, the engines of the Union G.I. were not serviceable in flight, but its size merits inclusion in this book. On 13 April 1915 the framework of the Union G.I was inspected by Government engineers, who called its construction good, but its estimated speed of 95 km.h. (59·4 m.p.h.) was criticized as being too slow, and its estimated bomb load was considered to be insufficient. It was powered by four inverted 110 h.p. Mercedes engines mounted as tandem pairs in fully-enclosed nacelles on the lower wing. The airframe was typical of the period, constructed of wood, wire-braced and fabric-covered; however, there is some indication that the fuselage was sheathed in plywood veneer. The taii assembly consisted of a single tailplane and elevator surmounted by three parallel rudders, the middle one hinged to a triangular fin. The designers of the Union G.I were Baurat Rittberger and Karl Schopper.

The Union G.I first flew in May 1915, subsequently it suffered damage, but its ultimate fate is unknown. Because Daimler had intentions of entering into the aircraft construction business, it placed an order for a second G.I and transferred a number of workers to the Union shops to learn the aircraft trade.

The airframe of the second Union G.I was strengthened, but overall dimensions remained the same. This machine, bearing the name "Marga-Emmy" painted on its nose, was stationed at the airfield in Schneidemühl. During a test flight on 1 September 1915 with pilot Thässler at the controls, severe engine vibrations forced him to make an emergency landing at Schloss Eberspark near Schneidemühl. The vibrations were so great that the G.I airframe broke apart shortly before touch-

down. There were no injuries to the crew. Structural weakness was the cause of the first G.I breaking in two during take-off or landing.

The aircraft were not rebuilt, but an improved version was continued as the Daimler R.I and Daimler R.II (page 86). On 1 August 1916 the Union-Flugzeugwerke went into liquidation and its assets were taken over by the Norddeutsche Flugzeugwerke, which spent the remainder of the war years repairing aircraft.

SPECIFICATIONS

Type:	Union G.I.
Manufacturer:	Union-Flugzeugwerke G.m.b.H., Teltow, Berlin
Engines:	Four 110 h.p. Mercedes Fh 1256 engines (inverted)
Dimensions:	Span, 21·0 m. (68 ft. 10½ in.)
	Length, 18·2 m. (59 ft. 8½ in.)
	Height, 3·74 m. (12 ft. 3 in.)
Areas:	Wings, 72·40 sq. m. (779 sq. ft.)
Weights:	Empty, 1960 kg. (4321 lb.)
	Loaded, 2765 kg. (6096 lb.)
Wing Loading:	38·20 kg./sq. m. (7·8 lb./sq. ft.)
Performance:	Maximum speed, 128 km.h. (79·5 m.p.h.)
	Cruising speed, 115 km.h. (71·5 m.p.h.)
	Climb, 1000 m. (3281 ft.) in 14·5 mins.
	1500 m. (4921 ft.) in 24·2 mins.
	Ceiling, 3500 m. (11,483 ft.)

Zschach R-Flying-boat Project

After the war details were published regarding the Zschach R-flying boat. This project was originally intended to produce a large naval bomber, but there is some question as to whether it received consideration by the German Navy. Nevertheless, the aircraft was an interesting design, and as such merits description.

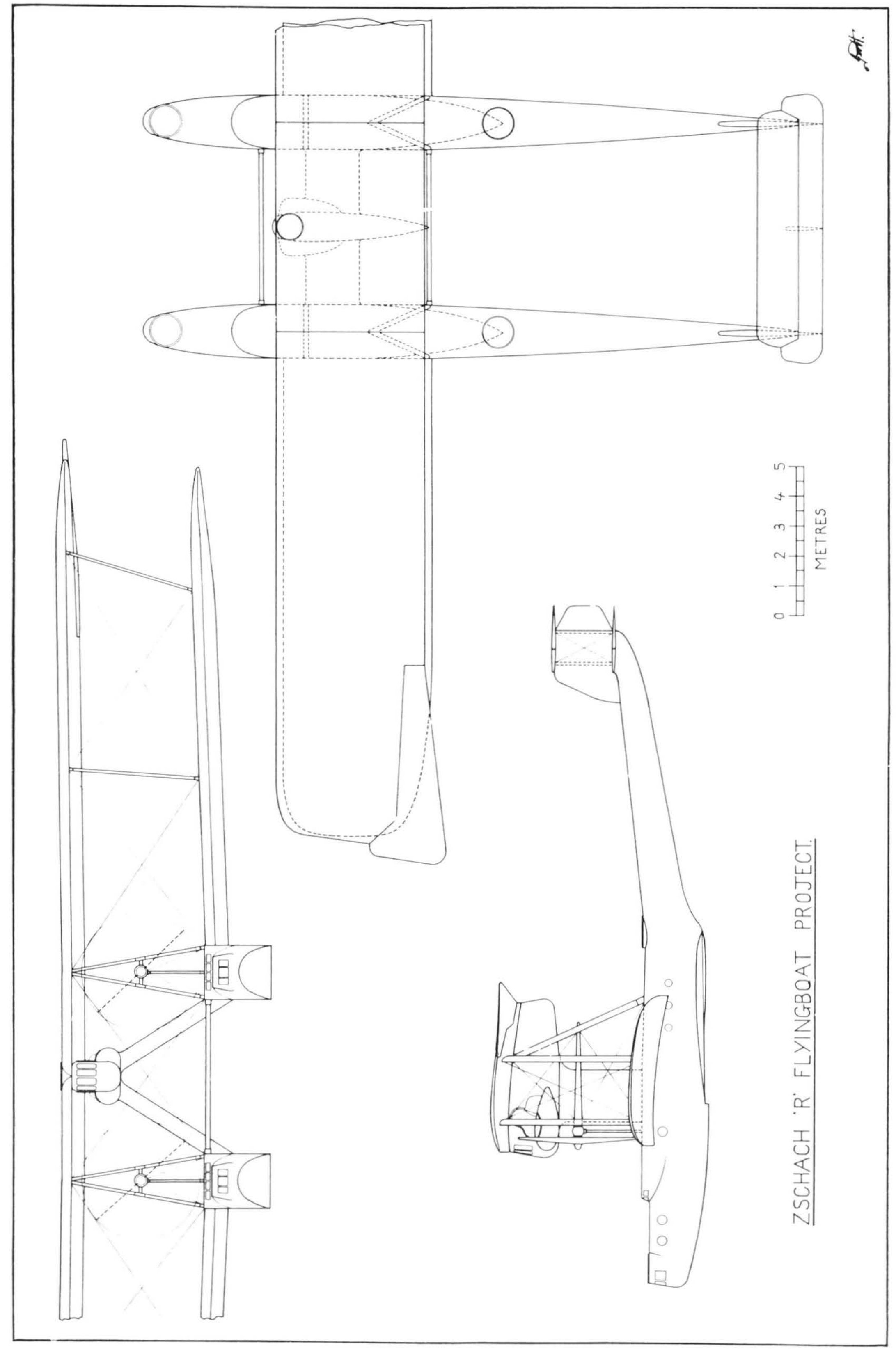
The flying-boat was designed by R. Zschach, an engineer who had been employed by the Hannoversche Waggonfabrik during the war, and it reflected the same careful design which characterized the Hannover two-seater fighters. The compartmented twin hulls were quite modern in appearance, and each contained two 260 h.p. Mercedes D.IVa engines coupled to a central gear-box, which in turn drove a single propeller mounted in the wing gap high above the influence of sea spray. Fuel was contained in three large tanks mounted below the engines. It was planned to arm the port bow and starboard dorsal gun positions with machine cannons, and the opposite positions were to be equipped with machine-guns. A wireless station was located in the port bow.

The hulls were joined by two robust struts at the centre section and by the tail assembly at the rear. Communication was provided by a covered ladder shaft which led from each hull to a centrally located control cabin attached to the underside of the upper wing. The cabin provided space for two pilots, one commander/navigator and, in the rear, for a substantial load of bombs. A fifth machine-gun post was situated near the leading edge of the upper wing above the cabin.

Both wings had slight dihedral and were of equal chord. The outer section of the wing, with its canted struts and balanced inverse-tapered ailerons, was very reminiscent of the Hannover Cl.II and Cl.III fighters.

The biplane tail unit, supported by two large fixed fins, mounted three rudders, but only the centre one was balanced, as were the twin elevators.

In its civilian version the Zschach flying-boat was intended to transport fifty passengers in the hulls, and a crew of five comprised of two engine mechanics, two pilots and an aircraft captain. Neither the military nor civil version of this aircraft progressed beyond the project stage, but it remains an aircraft which had pleasing lines and was modern in concept.

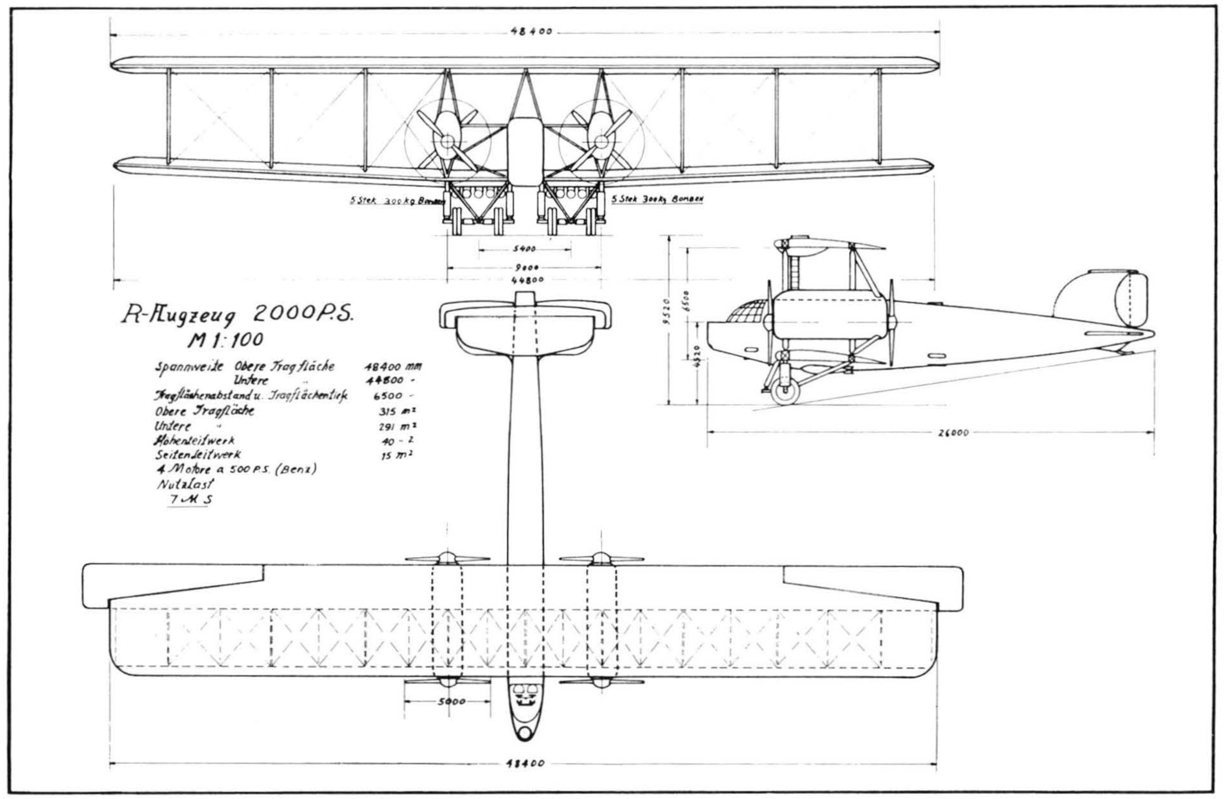


SPECIFICATIONS

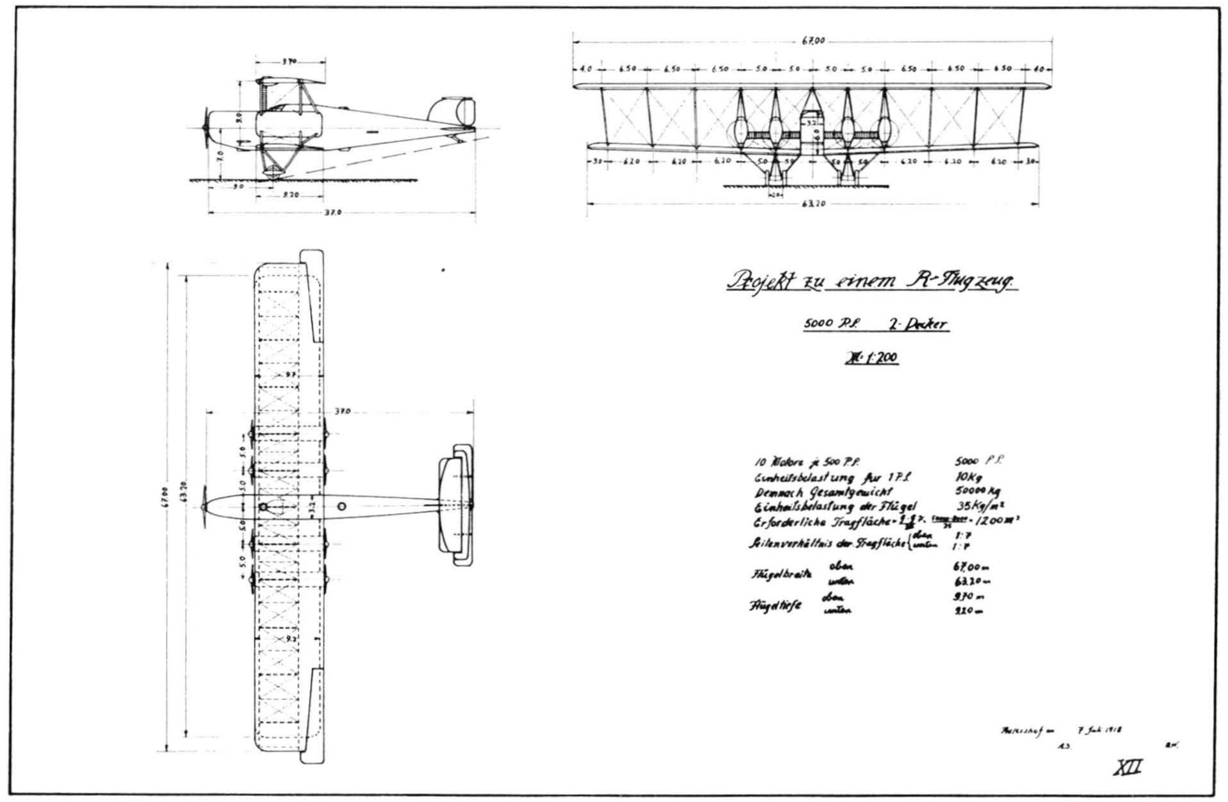
Type:	Zschach R-Flying-boat Project	
Manufacturer:	Designed by R. Zschach	
Dimensions:	Span, 42·7 m. (140 ft. 1 in.)	
	Chord, 5 m. (16 ft. 5 in.)	
	Gap, 4·75 m. (15 ft. 7 in.)	
	Stagger, 0·25 m. (10 in.)	
	Length, 22·8 m. (74 ft. 9½ in.)	
	Height, 7 m. (22 ft. 11½ in.)	
	Hull centres, 7 m. (22 ft. 11½ in.)	
	Tail span, 9 m. (29 ft. 6 in.)	
	Chord, 2·2 m. (7 ft. 2½ in.)	
	Gap, 2 m. (6 ft. 6½ in.)	
	Propeller diameter, 4 m. (13 ft. 1½ in.)	
Areas:	Wings, 350 sq. m. (3766 sq. ft.)	
Weights (Est.):	Hull,	1,200 kg.
	Wings,	1,950 kg.
	Control cabin,	210 kg.
	Tail unit,	165 kg.
	Engines,	1,770 kg.
	Transmission,	700 kg.
	Radiators,	200 kg.
	Electrical equipment,	160 kg.
	Fuel,	3,000 kg.
	Armament,	1,105 kg.
	Crew,	810 kg.
	Miscellaneous,	730 kg.
	Loaded,	12,000 kg. (26,460 lb.)
Wing Loading:	34·3 kg./sq. m. (7 lb./sq. ft.)	
Performance (Est.):	Speed, 128–140 km.h. (79·5 to 87 m.p.h.)	
	Climb, 3000 m. (9843 ft.) in 80 mins.	

The Adlershof Projects

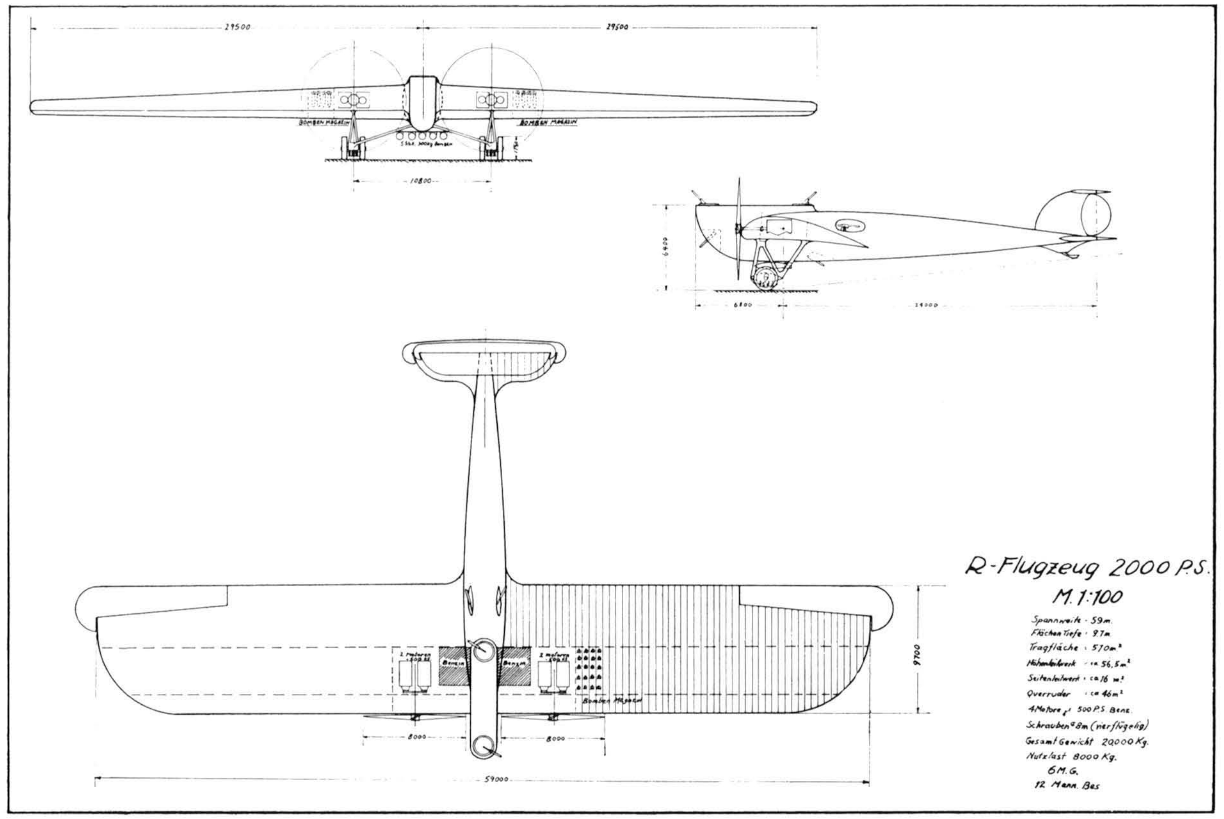
The following ten project drawings of R-planes were discovered among a pile of Zeppelin material that had found its way to the Air Museum at Wright Field. Even by today's standards, the size of some of the projected aircraft is immense, these drawings, more than anything else, reflect the thinking of German aeronautical engineers at the time. Unfortunately no information has been found to throw further light on these extremely interesting drawings. Six of the aircraft depicted follow the same twin fuselage configuration, differing in size and horsepower, and these show a strong resemblance to projected designs published by Junkers in the early 1920s. But the only concrete fact, apart from their existence, is that they originated from Adlershof.



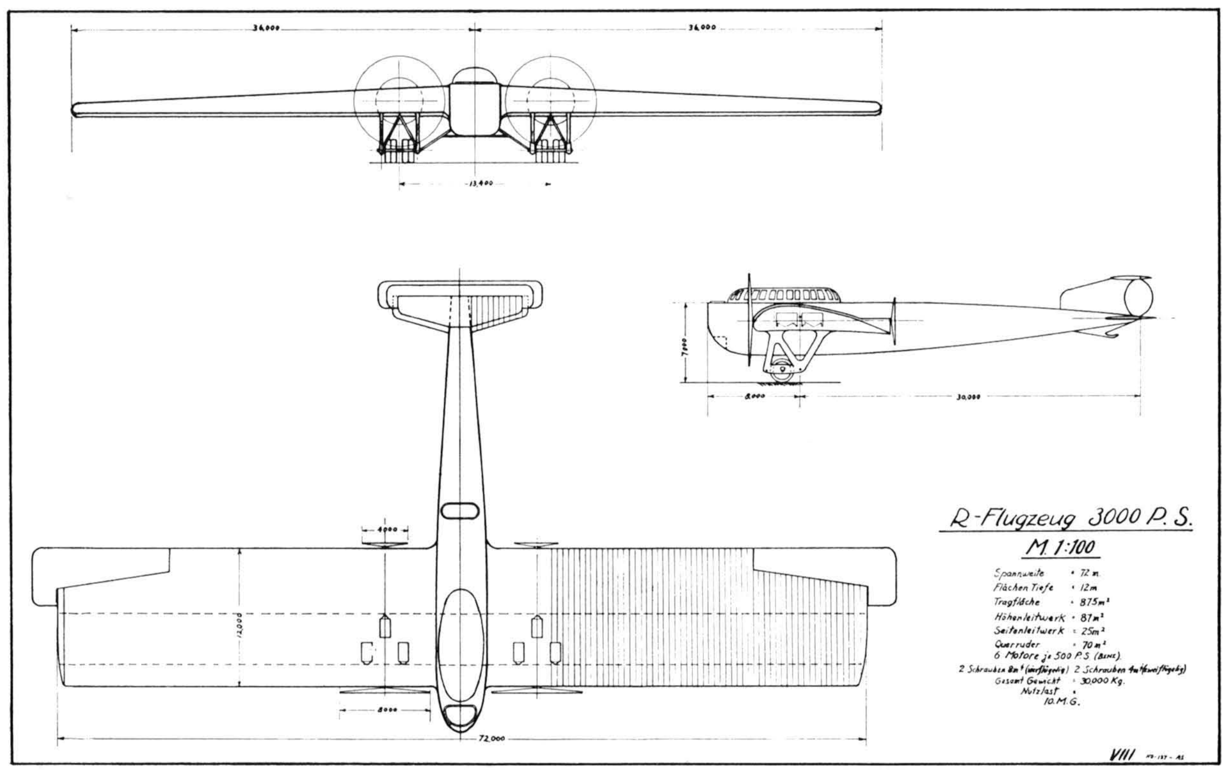
Adlershof R-plane project. 4/500 h.p. Benz. Span 48·4 m., length 26 m. 7 mg. This drawing shows a striking similarity to that of the Neuber project.



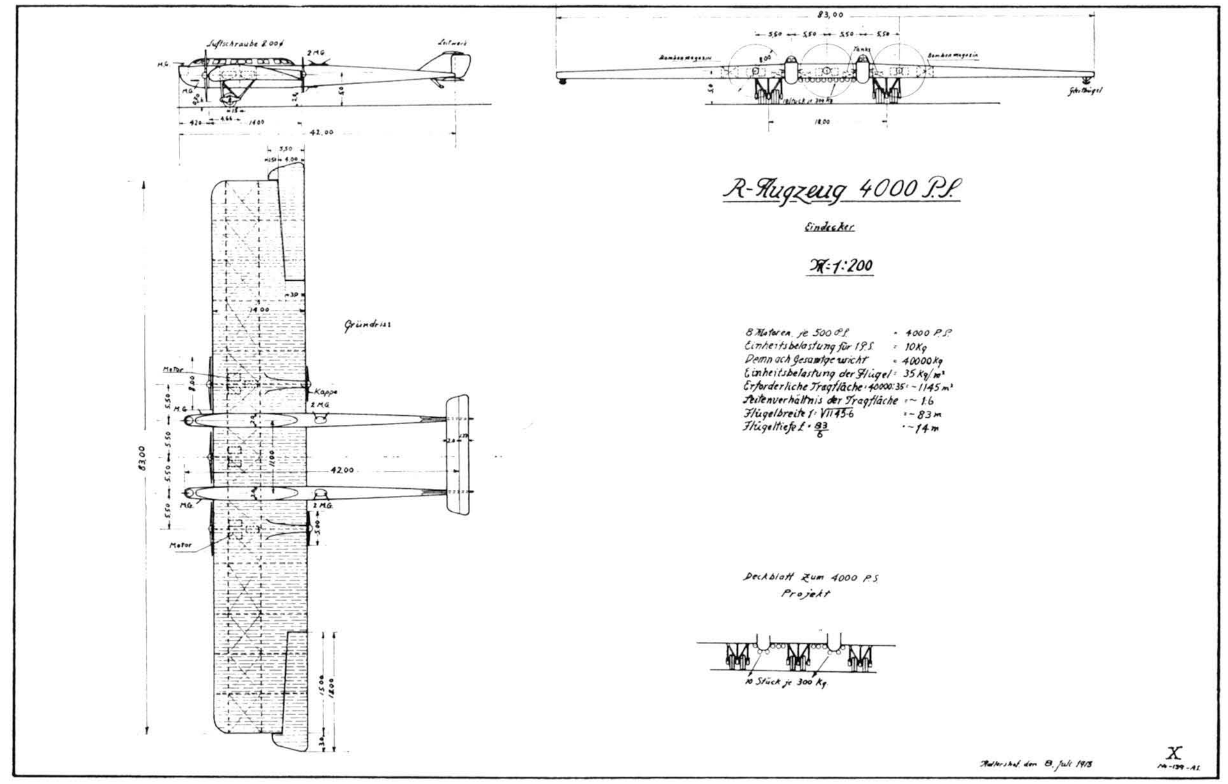
Adlershof R-plane project, dated 7 July 1918. 10/500 h.p. engines. Span 67 m., length 37 m.



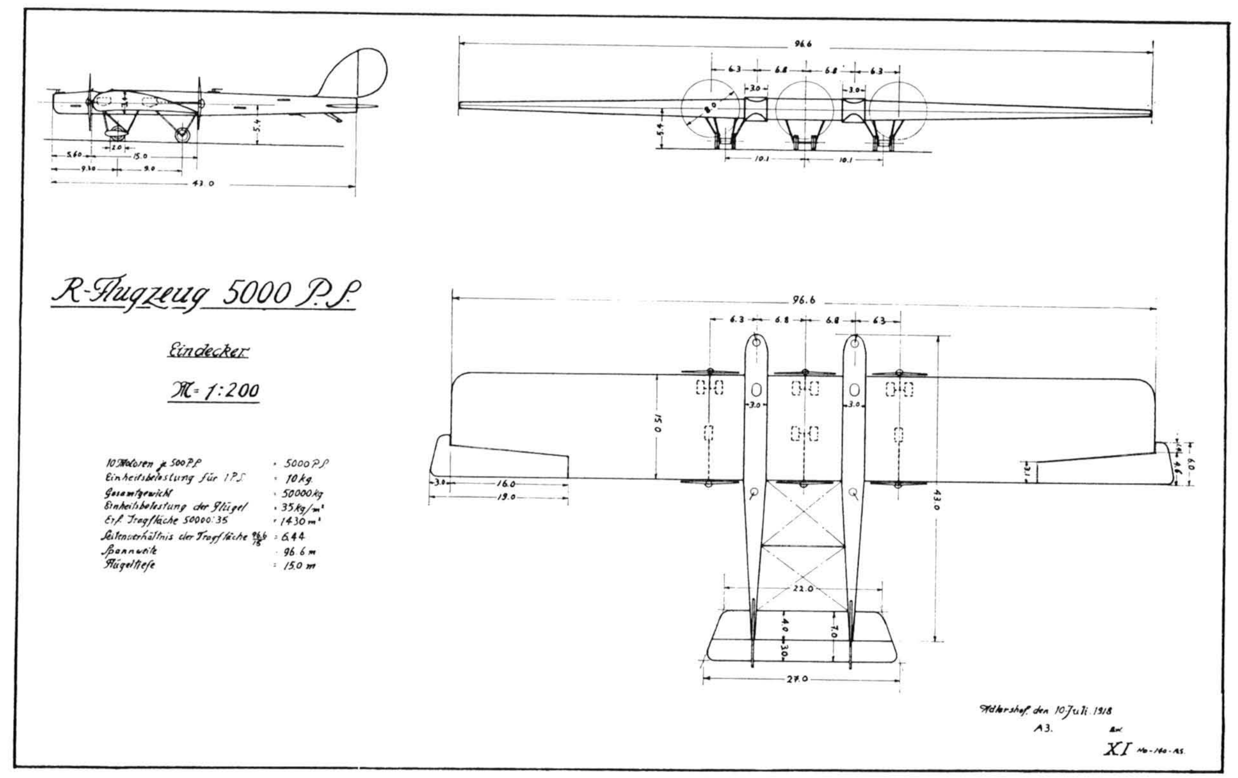
Adlershof R-plane project. 4/500 h.p. Benz. Span 59 m., length 30·8 m. 6 mg.



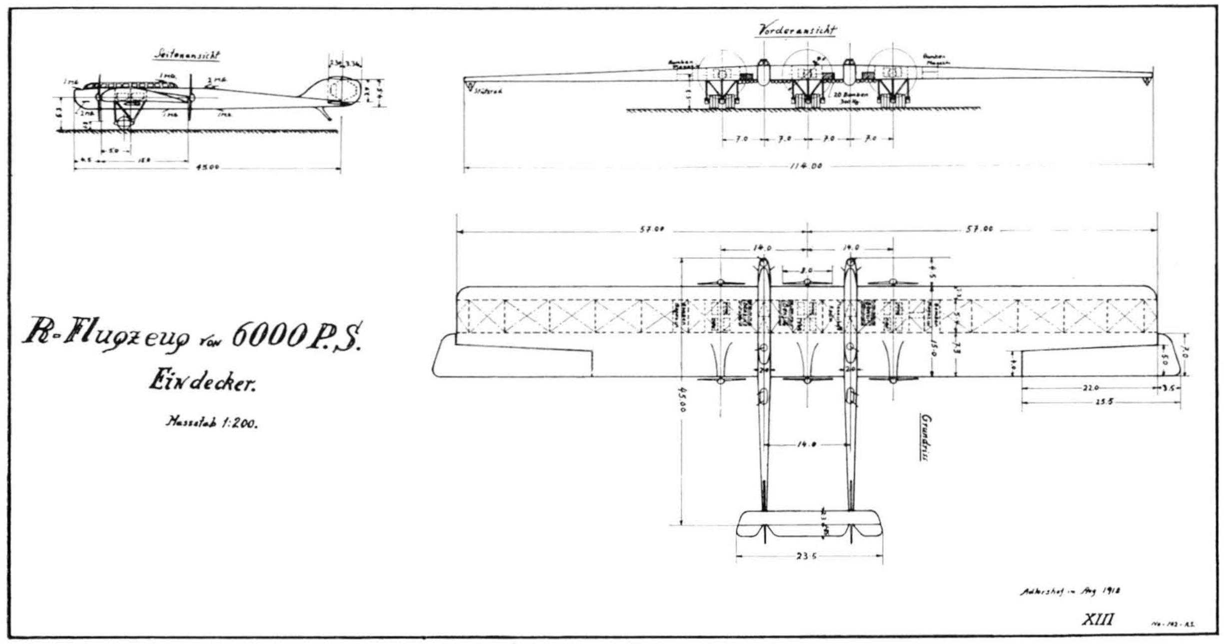
Adlershof R-plane project. 6/500 h.p. Benz. Span 72 m., length 38 m. 10 mg.



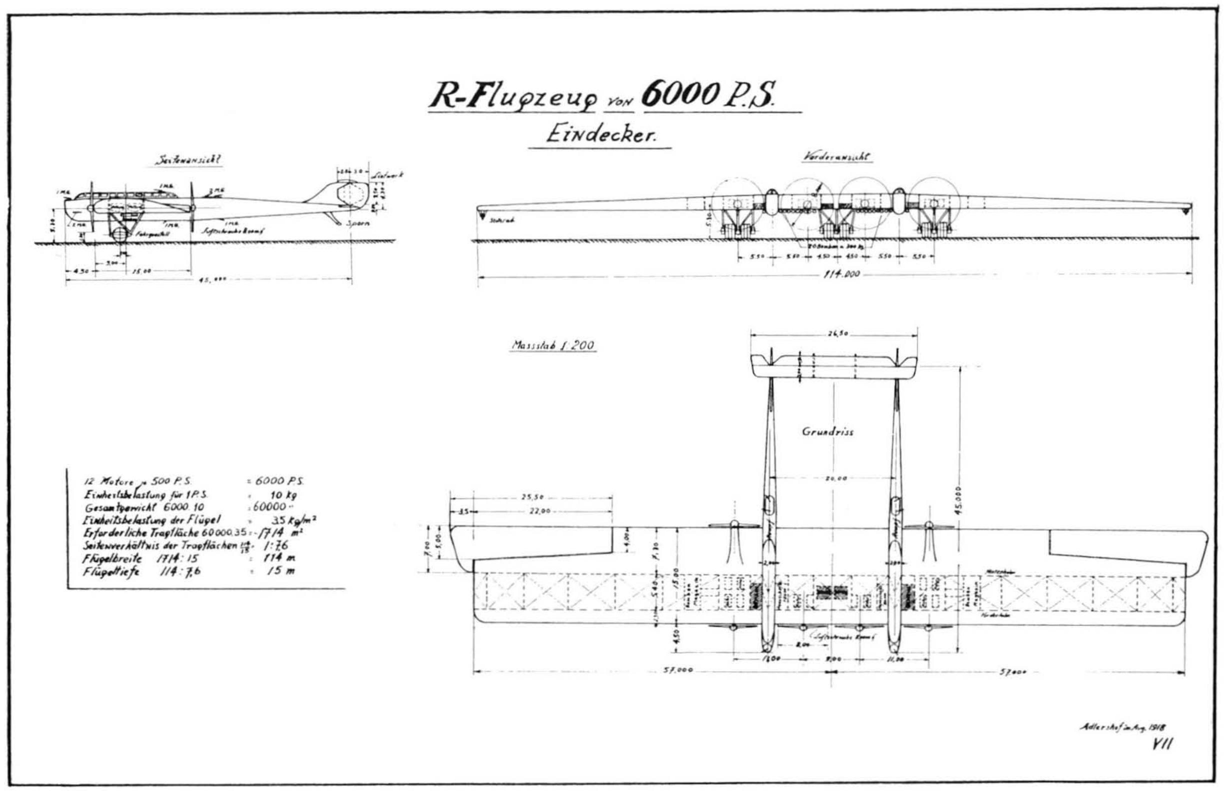
Adlershof R-plane project, dated 8 July 1918. 8/500 h.p. engines. Span 83 m., length 42 m.



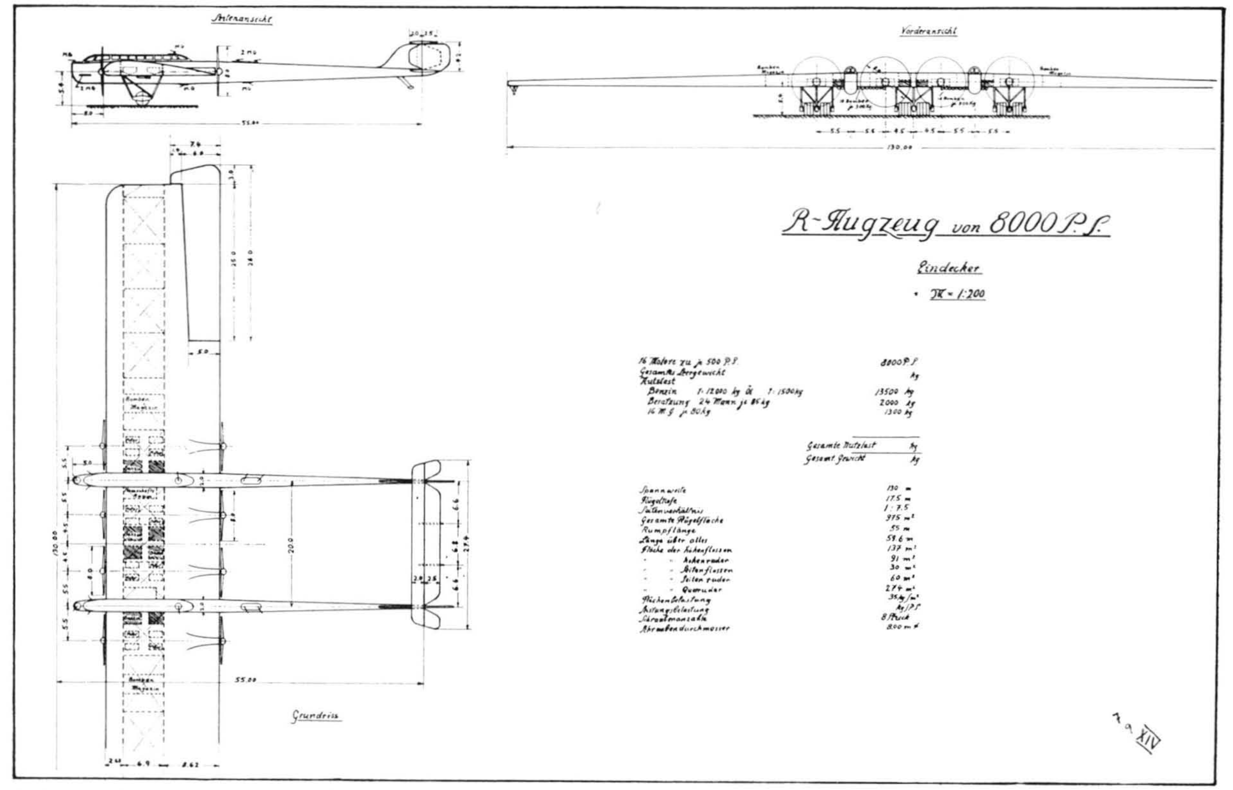
Adlershof R-plane project, dated 10 July 1918. 10/500 h.p. engines. Span 96·6 m.



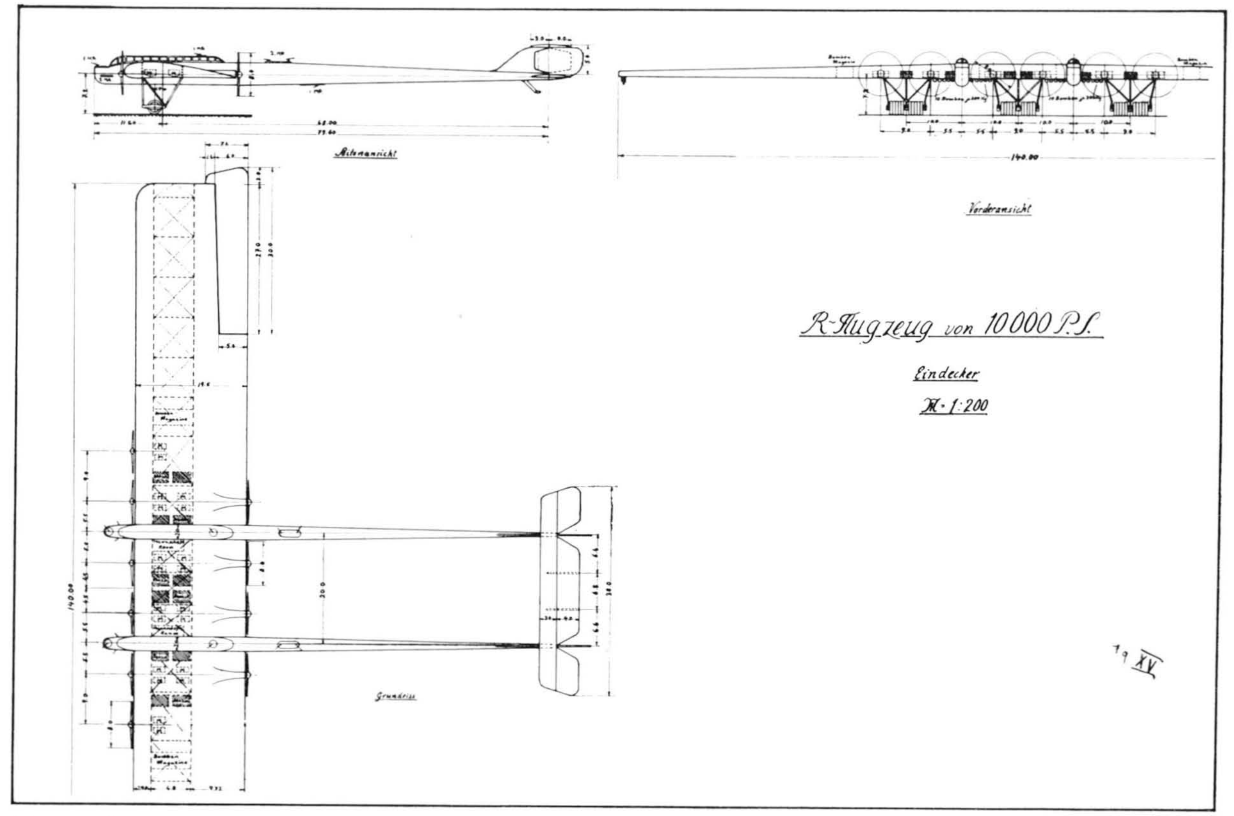
Adlershof R-plane project, dated August 1918. 12/500 h.p. engines. Span 114 m. length 48·36 m.



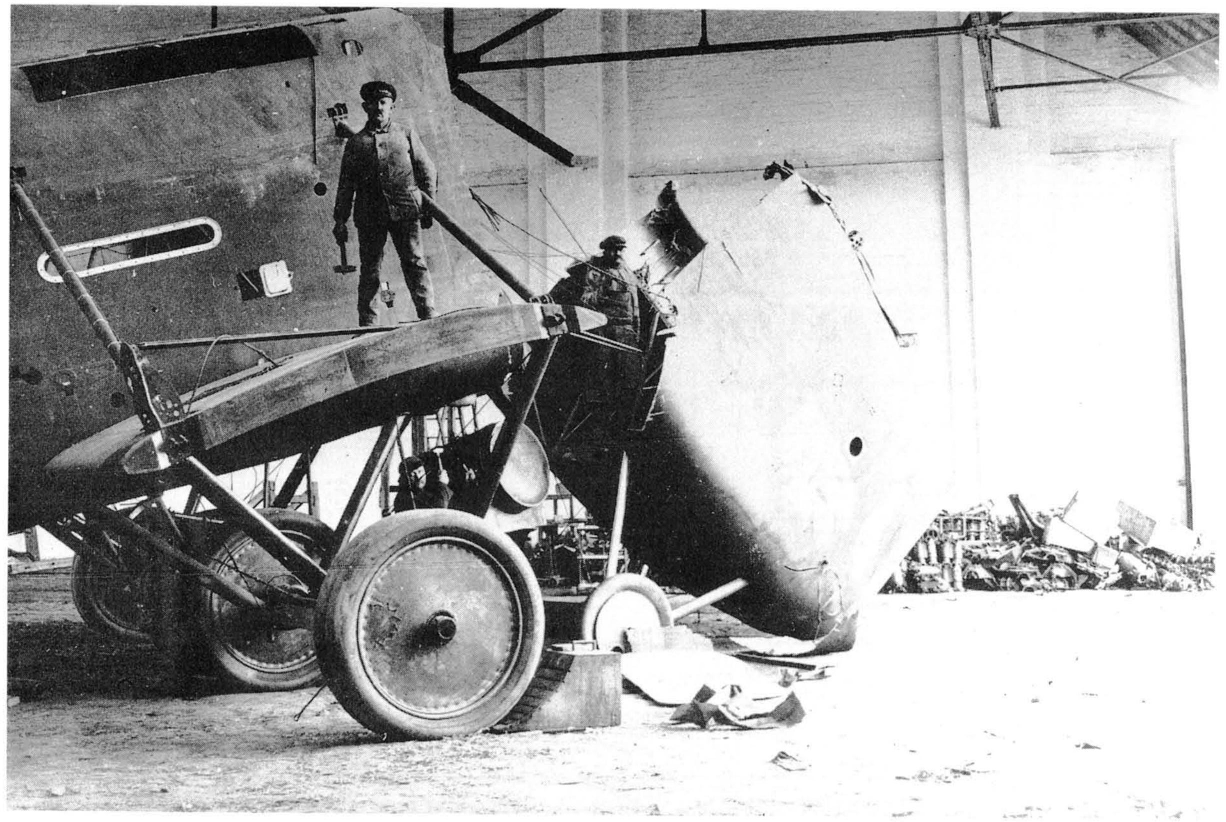
Adlershof R-plane project, dated August 1918. 12/500 h.p. engines. Span 114 m. length 48 m. This machine differs from that above in having four tractor and two pusher propellers.



Adlershof R-plane project. 16/500 h.p. engines. Span 130 m. A twenty-four man crew was planned for this aircraft. Armament comprised 16 machine-guns.



Adlershof R-plane project. 20/500 h.p. engines. Span 140 m.



The End! Photographed in 1920, a DFW R.II in the process of being destroyed in accordance with the Treaty of Versailles.

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Note: Many descriptive articles about individual R-planes appeared in German, English and French post-war periodicals such as *Flugsport*, *Illustrierte Flug-Welt*, *Aeroplane*, *Flight*, *L'Aerophile*, etc. Due to space limitations these general references have been omitted.

INDEX A—AEROPLANES

All aircraft mentioned in the book are listed in the index. **Bold type** signifies a specific description and the pertinent page numbers.

INDEX B—GENERAL SUBJECTS

This index is intended to serve as a general guide to subjects and personalities mentioned in this book.

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